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DEVELOPMENT OF COLONIAL RESOURCES

ALTHOUGH for ten months of the year under review Lord Trefgarne was still chairman of the Colonial Development Corporation, the third annual report of the Corporation*, covering the year ended December 31, 1950, bears the obvious imprint of the new chairman, Lord Reith. This influence can be seen in the references to the clarification and strengthening of the organization at headquarters and the better definition of responsibilities. All affairs and all staff will have their focus of decision, responsibility and authority in one or other of the members of an executive management board which is being formed. Measures have been taken to improve administrative and financial control throughout the whole organization, and schemes which show little or no prospect of paying their way are being radically overhauled, as with the Gambia Poultry Farm: they will be shut down if no sound alternative can be devised. Regional controllers, resident abroad, are to be appointed, and authority and responsibility to be devolved on them as far and as speedily as possible. Furthermore, it is contemplated that some schemes will ultimately be transferred to local ownership, with due safeguarding of Colonial interests and an adequate return on the Corporation's investment.

In all this, and in the further recognition of the desirability that the Colonial peoples should understand, approve and co-operate in the Corporation's schemes and objectives, and the assertion that the Corporation's own employees should be its best ambassadors, there is the new broom sweeping very clean. But it is equally clear from this report that the real problem is not that of efficient administration, welcome as improvement in that respect may be, but rather of objectives and of the place which the public corporation can take in Colonial development. It should dispel the complacent assumption which, as was remarked in a recent PEP broadsheet, has characterized recent discussions of the development of backward areas, including the Colombo Plan document—the assumption that the interests of the countries which would give aid and of those which would receive it are the same.

The *Planning* broadsheet, "The Strategy of World Development" (No. 327, April 23, 1951), issued by PEP, challenges this assumption that there is no conflict between the interests of the different kinds of countries which might be partners in development, and points out the danger of failing to investigate, to the full, conflicts of interest which in practice are very real, and to show that the economically advanced countries may themselves have different views on the type of development which they are willing to support. Discussion of important issues is thereby short-circuited, and especially consideration of what *Planning* terms the strategy of development is

* Colonial Development Corporation. Annual Report and Statement of Accounts for the Year ended 31st December 1950. Pp. vi+64. (London: H.M. Stationery Office, 1951.) 2s. net.

precluded. This broadsheet considers particularly the Colombo Plan, which tackles a problem outlined in an earlier PEP broadsheet on South-East Asia; but its main interest lies in its discussion of policy from the point at which the earlier discussions (such as the official report on the Colombo Plan for Co-operative Economic Development in South and South-East Asia (November 1950), the Report to the President on Foreign Economic Policies of November 1950 (generally known as the Gray Report), and that issued by the International Development Advisory Board in March 1951, containing under the title "Partners in Progress" detailed proposals for the development of backward areas) break off.

This wider survey of PEP at once challenges the suggestion that aid can be given to all under-developed areas at once, and raises the question of strategy, whether it is better to spread aid thinly but extensively, or to concentrate it on certain areas, and if so, which areas. The more limited survey of the Colonial Development Corporation, which is intended to undertake or participate in schemes beyond the scope of the private investor, brings us face to face with this same question of policy or strategy. The Corporation is bound over a period of years and over all its operations to be a financial success. The successful schemes must, in fact, pay for the failures. At the same time, the Corporation is bound to support any sound and reasonable scheme.

These considerations must be kept clearly in mind in reviewing the account of the Corporation's work given in the present report. Twenty-two new schemes were started in 1950, bringing the total to fifty, spread over twenty-two territories, and involving capital of £31,354,000, of which £10,175,962 has been spent. Agriculture accounts for the largest proportion of the schemes; the fifteen schemes have involved 25·2 per cent of the capital sanctioned. Four forestry schemes involve 12·5 per cent of the capital, five animal product schemes 12·3 per cent, six for factories 10·1 per cent, and four mineral schemes 9·5 per cent. Half this capital is for land development schemes, and 64 per cent for primary production, including, however, some capital for further processing of raw materials as, for example, canning. The loss on undertakings was £211,219 as against £84,730 in 1949, and the total deficiency for the year was £1,320,249.

While a few of the schemes have benefited from the steep rise in prices of Colonial products, and the immediate prospects of others have improved, most schemes have suffered from rising costs and delayed deliveries. Most of the schemes are, in fact, experimental, and welcome stress is laid in this report on the value of experimental or pilot schemes for providing the necessary scientific and technical data and for training the supervisory staff before large-scale operation is launched. The report recognizes frankly that failure and disappointment are inevitable in some aspects of the work for which the Corporation was established, and it points out that the political influence of the Corporation in the Colonies is apt to be exaggerated. The £100 million allotted to it is a small sum in relation to population and the new investment needed to achieve any considerable improvement in living standards, nor was it ever anticipated that by itself this sum would suffice.

If, however, the Corporation is to play its full part in Colonial development, it must succeed in attracting other capital and in stimulating co-operation with other bodies. The most suggestive passage of the report is that in which the idea is advanced that the experience and knowledge gained in operating the first group of schemes should form the basis for co-ordinated planning on a territorial or regional basis, and that the usefulness of the Corporation would be much increased if its own plans formed part of comprehensive colony or regional plans for development. A concrete example of such co-operation quoted in the report is the investigation of the coal resources of Tanganyika Territory, initiated at the request of the Tanganyika Government in 1949, on which £334,000 was expended in 1950. Geological reconnaissance has been completed by the Geological Survey of Tanganyika over the Kitewaka field, and a detailed geological survey by the Corporation is now under way. The investigation, moreover, is closely linked with the Tanganyika Government's plans for railway extension, and was accelerated in 1950 at the request of that Government, because results are required for determining alignments.

It would be most unfortunate if such spectacular failures as that of the Gambia Poultry Farm which, as announced by the Secretary of State for the Colonies in the House of Commons on May 9, is now to be abandoned as such, should divert attention from the potentialities of the Corporation in other directions. The Nigerian Fibre Industries is a pioneer scheme, in which part of the capital is to be subscribed by the Nigerian Cocoa and Cotton Marketing Boards, and is typical of schemes which, if successful, could be expanded or copied elsewhere. Again, the Corporation has sent a mission to British Guiana to study proposals for increasing rice production and for rationalizing the milling industry in partnership with the Government, but the production of sugar in British Honduras is regarded as commercially unattractive. A plan for a pilot cattle-ranching scheme which will test the possibilities of the hitherto undeveloped area of the Keningau plain, North Borneo, was approved in February 1951; but plans for the construction of a mutton-freezing plant in Somaliland had to be abandoned because of risk of transmission of rinderpest. Other possibilities of utilizing this potential source of meat supply are being explored, as well as several schemes for the expansion of livestock in Africa.

Other schemes outlined in the report indicate both the need for co-operation and the way in which schemes may be suggested by the desire to meet the needs of the United Kingdom as well as those of the Colonial territories. But the central issue raised by this report is whether or not the work of the Colonial Development Corporation would not be mainly and more effectively carried out by decentralization into

a number of local development corporations in individual or groups of Colonies. Such an idea was advanced when the Colonial Development and Welfare Bill of 1945 was passing through Parliament. A central organization in London would still be required for advice and to assist in obtaining technicians and equipment, as well as in planning the general strategy or policy of development. If, however, the local governments had a large share in the finance and in the management of the boards, and were able to relate schemes to their own development and welfare plans and to their labour and fiscal policy, something more might be achieved than a reduction in the number of costly failures. There might be a most important contribution to the economic education of the Colonial territories which would help to restore a balance that has been upset by rapid developments in the political field.

The bearing of such regional developments on self-government is one reason for considering seriously the issues raised in the *Planning* broadsheet already noted. The main conflict of interest, as that broadsheet emphasizes, is between the case for development policies designed first and foremost to improve conditions of life in the backward areas, and the desire of advanced countries to improve the supply of primary products. Development corporations, whether regional or not, cannot ignore this conflict, or the fact that different development policies can give very different distributions of benefit. Those types of development which yield the greatest economic benefit to advanced countries are by no means necessarily those which do most to improve conditions of life in the backward areas. The choice of types of development by the advanced countries will be limited by the resistance of backward areas to some of the means of development, as well as by various fears and suspicions which regional corporations might perhaps diminish, although they might not entirely remove them, and this can extend, as PEP points out, even to questions of technical aid.

Technical aid is a necessary concomitant to the other forms of aid; but if it is to extend so far as to ensure the conditions of government and public finance necessary for the economic development of backward areas, outside interference is involved of a type which is likely to be resented. Nevertheless, the hard fact remains that government and financial reform is a prerequisite of development in many such areas. Both the scale and the strategy of development must take account of such limitations, no less in dependent than in independent territories.

On that issue of strategy, *Planning* takes it as axiomatic that nothing would be gained by spreading over too wide an area the limited material and technical aid likely to be made available by the industrial countries. In most backward areas, no spectacular development in production can be expected without a considerable amount of investment, which does not itself yield directly any great increase of production. Unless carried beyond a certain point, development in any of the more backward areas will be fruitless.

As to the selection of areas for early development, the broadsheet emphasizes that there is still a wide range of choice, although attention to-day is concentrated on southern Asia, with the Middle East as the next probable focus. It is necessarily a matter of judgment how much priority should be given to programmes the prime object of which is to gain or keep the goodwill of particular areas for political or military reasons. In south-east Asia, for example, dependence on adequate supplies of raw materials reinforces considerations which are more narrowly political, and this equally applies to the Middle East. At present, the United Kingdom, Canada, Australia and New Zealand are committed to the Colombo Plan, which, in view of the strain of rearmament, is likely to absorb the bulk of the resources they will be able to provide for external development in the next few years.

To attempt to scale down the Colombo Plan would be a political disaster; but British commitments under the Plan may well affect considerably the future of the Colonial Development Corporation. The extent of present irrevocable commitments, indeed, should impel the Government to attempt to evolve some policy or strategy in co-operation with others. Where development is considered as a means of increasing supplies of primary products, the choice of areas obviously depends on technical and economic considerations. Resources should be directed to places where they will yield the greatest returns in terms of desired goods, though even here much more is involved than a simple comparison of physical yields.

Essentially, the PEP broadsheet is a challenge to advanced countries to think out on a long-term basis their programmes designed to raise standards of life, and for Great Britain it indicates the background against which both the policy and the field and scale of operations of the Colonial Development Corporation should now be considered. There may, for example, be some advantage in giving priority of aid to countries which have already passed the arduous first stages of development; their production is likely to be increased faster, and the advanced countries may hope to pass fairly soon to the promotion of development elsewhere. But the most important decisions are not of place, or even of means, though suitable financial institutions are needed, so much as of ends; though the Bechuanaland and Swaziland schemes may well be of decisive importance in view of the position in the Union of South Africa. The crucial question is the balance to be struck between development designed to increase the supplies of primary products wanted by the advanced countries, and development designed to improve conditions of life in backward areas. By directing attention to the conflict of interests which may be involved, the PEP broadsheet helps both to dispel the loose thinking which has sometimes obscured the issues, and to make it more difficult for the ill-disposed to make mischief between the Western democracies and the dependent or independent peoples of Africa, Asia and the Middle East.

PLANT BIOCHEMISTRY

Plant Biochemistry

By James Bonner. Pp. xvii+537. (New York: Academic Press, Inc., 1950.) 6.80 dollars.

THERE are many reasons why studies on the biochemistry of plants have appealed to so few research workers in the past. The plant is a very independent organism, and for its growth or sustenance it requires no prepared organic nutrients. When starved or diseased it may look 'off colour'; but it cannot, like most mammals, yell and so let the whole world know. Perhaps it is this self-sufficiency which unconsciously leads us to take all its living processes for granted and to withhold our pity when it is ill. Certainly the endowment for research on plants has lagged far behind that for research on the animal or human: a rich man may pay readily in the hope of prolonging his own life, yet when all is not well in his garden he generally thinks only in terms of gardeners' wages. Fortunately, that greatest of all industries, agriculture, has at last become alive to the lack of fundamental knowledge in the physiology, biochemistry and pathology of plants, and there is reasonable hope that within the next few decades the leeway may be made up.

It must be admitted that the plant is not an easy medium for physiological or biochemical research. The well-trod paths for the study of the intermediary metabolism in the mammal, the blood stream, food ingestion and excretion, etc., are not available, and attempts have had to be made to obtain knowledge indirectly by treatment or analysis of organs such as the root system, leaves and fruits as entities; seldom, indeed, has it been possible to make use of their more highly specialized component parts. For this reason, many have felt that research on the plant might well await the outcome of the present intense drive to elucidate the biochemistry (especially) of the micro-organisms. While the subject-matter of Prof. J. Bonner's book demonstrates that such work is of value as a guide to studies with higher plants as well as with mammals, it also brings out quite clearly that many of the recent advances in various branches of plant biochemistry itself have contributed more than their share towards establishing the basic similarity in the metabolic processes of living organisms in general. There can be no doubt that plant biochemistry has an interest and a discipline of its own which should not be overlooked by the younger workers who are considering the field of research to which they might devote their lives. More recruits for plant biochemistry are certainly needed, and those who are still hesitant will find all the inspiration they need from a close reading of Prof. Bonner's text.

The book is cast in the form of a brief introduction, followed by six main parts dealing respectively with carbohydrates and carbohydrate metabolism, the cell wall and cell-wall metabolism, plant acids and plant respiration, metabolism of nitrogenous compounds, secondary plant products, and certain aspects of plant growth. These parts are further subdivided into appropriate chapters, each of which is a résumé of the present knowledge of some particular topic and carries its own list of selected references to the original literature. The subject-matter throughout is very readable and is not overburdened with chemical detail: the author has, in fact, struck an admirable balance and has written a book which is far more comprehensive than any of its predecessors. Recent advances in the knowledge of the proteins, carbohydrates and lipids are described in a concise and illuminating way, the emphasis being directed towards their metabolism and their inter-relationships through the Krebs cycle and respiration. The carotenoid and other plant pigments receive adequate attention. Prof. Bonner is to be congratulated on a fine presentation of a subject that is clearly very dear to his heart.

ELECTROMAGNETISM FOR ENGINEERS

The Principles of Electromagnetism

By Dr. E. B. Moullin. (Oxford Engineering Science Series.) Second edition. Pp. viii+312. (Oxford: Clarendon Press; London: Oxford University Press, 1950.) 20*s*. net.

PROF. E. B. MOULLIN's book on the principles of electromagnetism, first published in 1932, very quickly took its place among the standard text-books of the subject. The new edition is a reprint of the old, but incorporates an extensive second appendix.

In scope the book may be said to cover the basic electromagnetism required for a university course in electrical engineering. Various topics are, however, selected for a detailed treatment which is much more thorough than is common in undergraduate texts. The topics so selected are naturally those which are of major importance in applied electromagnetism. "Iron in a Magnetic Field", for example, occupies some eighty-five out of a total of just over three hundred pages. Phenomena and concepts which are often uncritically accepted are examined in a searching fashion so as to elucidate their mechanism. A case in point is the discussion of the behaviour of the iron ring with a concentrated magnetizing coil. Magnetic shielding also receives an unusually thorough treatment, and the same may be said of the analysis of eddy-current phenomena. The new appendix, besides extending the discussion of eddy currents, makes a brief but useful excursion into the dielectric field to deal with the energy loss in capacitors. The final chapter is devoted to the development of Maxwell's equations, and there is a short section on retarded functions. The treatment does not presuppose a knowledge of the methods of vector analysis.

The whole book expresses originality of outlook. No doubt one or two of the basic postulates will be unacceptable to some readers, for example, the isolated magnetic pole or the identity of character of the quantities B and H; but cogency and lucidity of argument and aptness of illustration transcend such barriers. The following sentences dealing with the calculation of mutual inductance may be quoted as typical, and such aphorisms abound. "So when the reader has to calculate M for a particular problem, he should remember that if the integration seems intractable for evaluating M_{12}, it may be quite simple for evaluating M_{21}. If a coil B looks unpleasant, in a mathematical sense, when viewed from coil A, then go to coil B and see if coil A presents a more pleasing prospect. The property that $M_{12} = M_{21}$ presumably supplies the answer to some definite integrals which could not otherwise be evaluated." This book is not

only a guide and friend for the undergraduate, but it can also remain a stimulating companion in mature experience.

It is rather remarkable, but no doubt deliberate, that the conventional vector diagram of A.C. circuit theory is not utilized at all in the work even to illustrate skin effect phenomena to which this representation is well adapted. At least one group of minor misprints has been transmitted from the first edition, namely, the omission of 'dx' from several of the equations on p. 241. JAMES GREIG

SPECTROCHEMICAL ANALYSIS

Metal Spectroscopy

By F. Twyman. Pp. ix+569. (London: Charles Griffin and Co., Ltd., 1951.) 50*s*. net.

THE development of spectroscopy proceeds with ever-increasing pace: from the discovery of the spectrum by Newton in 1672, the use of flame spectra to distinguish between lithium and strontium by Talbot in 1834, the spectroscopic discovery of cæsium and rubidium by Kirchhoff and Bunsen in 1861, and the first serious attempts at spectrochemical analysis by Hartley and de Gramont at the turn of the century, to the present, when the all-pervading science of electronics is being applied to spectrochemistry. The historical side is most readably presented in the opening chapter, but the importance of this book is in its complete and up-to date treatment of recent developments in a rapidly expanding field. These rapid developments have led to the replacement of Mr. Twyman's "Spectrochemical Analysis of Metals and Alloys", which was written during the difficult early war years and published in 1941.

Mr. Twyman has been outstanding in the development of spectroscopic equipment and technique, and his experience in the field extends back half a century. Although he has been so closely associated with Messrs. Adam Hilger, Ltd., this book is not tied to the instruments of this firm, and the important contributions to spectrochemistry from Germany, the United States and other countries are given full weight, and the instruments of other firms are fully covered.

Practically every aspect of spectrochemical analysis is dealt with in more than five hundred closely written pages. There is a short chapter dealing with the fundamental principles of the theory of atomic spectra (the unusual notation of writing the upper state of a transition to the left may be noted), but thereafter the emphasis is on the instruments and experimental technique; this practical aspect may be illustrated by the section on shielding of sparks to prevent radio interference. Chapters on light sources, electrodes, X-ray spectrochemistry, and the present trend of developments are contributed respectively by A. Walsh, M. Millbourn, F. Brech and F. Holmes.

For the analysis of metals, especially in routine testing of numerous samples, or in detecting trace elements in soils, spectroscopic analysis obviously has many advantages; but it is not only for metals that it can be used, and the book also covers analysis of gases and of some non-metals such as sulphur, selenium, carbon and boron. Colorimetry and spectrophotometry, microphotometers, the infra-red region, and the use of spectrochemical analysis combined with chromatography are also dealt with. An interesting suggestion is the possible extension to shorter wave-lengths, perhaps by the use of fluorite prisms, to reach more sensitive lines such as those of sulphur and selenium. Types of instruments are compared, and, while Mr. Twyman admits that gratings have some real advantages, the limitations due to overlapping orders, astigmatism and ghosts are pointed out.

This book is by far the most comprehensive and authoritative treatment of the subject available, and is strongly recommended. If there is a weakness it probably lies in the presentation: the table of contents only gives chapter headings, and as these are in general terms it is not always easy to find the section of interest—thus Raman spectra come under "Electronic Methods". There is a good bibliography, and the book is well produced. A. G. GAYDON

RHODODENDRON LEAVES

The Rhododendron Leaf

A Study of the Epidermal Appendages. By Dr. John Macqueen Cowan. Pp. xi+120+18 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1950.) 21*s*. net.

THE study of the rhododendrons has long been pursued in the Royal Botanic Gardens, Edinburgh, blessed by an ever growing wealth of living plants and by unswerving interest in taxonomy. Throughout this time a widespread view has come that, while specific status or generic rank may well be proved by form and stature of papillæ or of hairs or scales retained on mature leaves, in other respects the forms and groupings of the hairs or scales may point to true relationships, the seekers of which have hitherto all assumed that species bearing scaly leaves are of distinct descent from all those that have hairy leaves or lack such dermal organs.

This broad assumed distinction was employed throughout "The Species of Rhododendron" (1930), both in the seriation of the plants described and often, too, as if it can denote for new-found or for doubtful plants some special series which already hold their nearer kith and kin. Although this standard book allowed that certain series then proposed embrace confusing plant assemblages, its plan again implied that plants with hairs or scales are rightly viewed as of distinct descent.

The present handsome book relates how, though so often contrasting in their forms and states, the hairs and scales which many species bear alike arise from single superficial cells, and how their products must be held of unit kind, though built on diverse plans. Since it shows, too, how dermal organs borne by hybrid plants may stand in all respects between hairs and scales, how certain species vary much in types of hair-display, and how, in others, hairs and scales are formed on every leaf, it seems the old assumption must be set aside until it is known what hair- and scale-formation mean to living plants themselves.

No matter how these findings bear on taxonomic problems, this book has interest far beyond the field of systematics or that of horticulture. It first relates how needful lines of study grew from those already traced, and how through simple technique knowledge came of many trichome-forms which had not always drawn comment or were misunderstood. Each one of these is then described and faithfully portrayed

before it is shown what founded species-series are still justified, and which must be revised.

Throughout its length, this book impresses one by the author's sense of plants as living things, each posing many problems still but slightly grasped and which must duly be essayed if one should hope to picture near relationships.

Although the major chapters brim with novel observations, they rather seek to urge research than to suggest conclusions. Perhaps the final chapter will serve the most to quicken new inquiry; for, vividly, it turns the mind from plants in cultivation to an understanding of, in part, their fitness to their native habitats and their sustained survival.

This simply written book reflects a long and arduous effort. Its illustration merits special praise, as does its composition. J. McLean Thompson

A POPULAR NATURE STUDY

Nature through the Year

By Frances Pitt. Pp. vii+300. (London: Macmillan and Co., Ltd., 1951.) 18*s*. net.

Frances Pitt's literary excursions in natural history are now so well known that there can be few with love of Nature who have not met her in person or print. In her latest work this popular writer presents a colourful account of natural events throughout the year. As always, the book is written in a delightful narrative style which is accompanied by evidence of acute powers of observation stemming from keen interest in and love of living things.

In some ways the title of the book is a misnomer. Although other aspects of Nature are referred to, Miss Pitt is mainly concerned with birds and mammals, and these, not unexpectedly, sometimes include those well-loved pets with which the author has had long acquaintance and studied so carefully. The book, in fact, would serve as an admirable supplement to the popular "In Britain" series by the same publishers, particularly if these in turn were strengthened by a work dealing with insects in Britain.

The arrangement of the book is on a weekly basis. Beginning on January 1 and continuing for each successive week throughout the year, the author has recorded significant impressions which she has observed, and has used these as starting points for gentle dissertations on biological principles or practices. An encounter with a hare, for example, leads naturally to discourse about animal camouflage, while genetic principles are introduced after a mild detective story in which a Manx cat is the chief suspect.

In these voyagings Miss Pitt does not hesitate to roam wherever fancy takes her, and one of her weekly episodes begins with an account of a squirrel's reaction to the sting of a wasp, continues with the description of a squirrel which had "bilious" attacks which may have been brought on by eating Brazil nuts, and finishes with possible explanations of old legends about spectral horsemen and ghostly hounds running equally ghostly quarry through the night; these vagaries do not detract from the charm of the book. Nor do some minor errors, although, when another edition of the book is called for, Miss Pitt should not—on p. 73—begin a sentence by saying that she "could not give a *definite* answer", and end it with "the reason is *undoubtedly* one of light and lighting". So, too, with other parts of the text which appear to have been hastily written and have become so loosely constructed that, as on p. 289, the author has exposed herself to the charge of anthropomorphism.

The book is generously provided with black-and-white illustrations, the photographs for which were taken by Miss Pitt; the majority of these are clear but a few are well below the standard associated with the publishers.

In a world where the search for truth has become so objectively impersonal that much present-day writing lacks the warmth and colour of human emotion, Miss Pitt's book makes refreshing and interesting reading mainly because the author has nowhere tried to conceal her feelings and idiosyncrasies.

Besides British readers, "Nature through the Year" would be an admirable guide for visitors from overseas who have come to examine Britain as she really is in Festival year. T. H. Hawkins

ATOMIC REMINISCENCES

New Atoms

Progress and some Memories. By Otto Hahn. A collection of Papers, edited by Dr. W. Gaade. Pp. 184. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1950.) 12*s*. 6*d*.

Though there has been a number of books purporting to expound the scientific facts about 'atomic energy' to the non-technical reader, this little volume should hold its own. It is a collection of four lectures, each complete in itself; hence some overlap is unavoidable. The first is the Nobel Lecture given by the author in 1946, and is an account of the work which led up to the discovery of nuclear fission. The occasions on which the other three lectures are given are not stated; the second is largely physical, centred around the nuclear chain reaction which followed soon after the discovery of fission. In the third, the author is at home again in his beloved chemistry, zestfully describing the new elements (no less than ten) which recent nuclear research (not all of it directly connected with fission) has given the chemists to play with. The last brings reminiscences of the early years of radioactivity; less technical and often humorous, it paints a lively canvas of those heroic days when radium was new and anything might happen.

The style is very straightforward, indeed rather subtle in its simplicity. It avoids the long-winded explanations which are apt to stress rather than resolve difficulties, and it is also refreshingly free from that hectic verbiage by which some popular writers lash the flagging attention of their jaded readers. Much of the information given, particularly in the third lecture, is fairly technical; but it is always presented in simple language. Perhaps the most valuable feature is the sense of historical unity, connecting early radioactivity and modern atomic energy, a unity of which the author is a living symbol and which he succeeds very well in communicating.

On the whole, this is a most likeable little book, written by a man who took a leading part in the development of radioactivity and who enjoys telling us about his work and the scientific scenery in which it took place. The translation is good; a few minor slips are easily spotted and do no harm.

O. R. Frisch

Solvents

By Dr. Thos. H. Durrans. (Monographs on Applied Chemistry, Vol. 4.) Sixth edition, revised and enlarged. Pp. xv+242. (London: Chapman and Hall, Ltd., 1950.) 21*s.* net.

THIS well-known and useful monograph was first published in 1930 to provide a scientific exposition of the technical application of solvents, more particularly in connexion with the cellulose-lacquer industry. The considerable advances in the production of solvents and plasticizers during the past twenty years made it necessary to subject the book to frequent revision if it was to retain its usefulness as an up-to-date manual, and it has now reached its sixth edition, which fully maintains the standard of its predecessors.

The general arrangement of the previous editions has been retained, the first part of the book discussing the more theoretical aspects of the subject, and the second part dealing with the characteristics and uses of individual solvents and plasticizers. The chapter on toxicity has undergone considerable revision and extension in the light of recent discoveries and opinions. Appendixes give a very useful and comprehensive list of trade names with probable compositions (now extended to some 576 entries), solubility tables and plasticizer proportions. The solubility tables give information on the solubility of twenty-seven different substances, such as cellulose acetate, rubber, gums, oils, etc., in more than a hundred different solvents.

The present edition may be accepted as containing the most recent information and experience in its particular field, and can be recommended with confidence to all who have to deal with solvents and plasticizers. E. H. NURSE

British Journal of Applied Physics

Edited by Dr. H. R. Lang. Vol. 1, 1950. Pp. iv+340. (London: Institute of Physics, 1950.) £4.

THE monthly periodical, *British Journal of Applied Physics*, was launched in January 1950 by the Institute of Physics in order to provide the steadily increasing number of physicists employed in industry with a medium for the publication of new applications of physics, especially in industry, and for the description of developments of older applications. The completion of Vol. 1 provides a welcome opportunity to direct attention again to the excellence of the *Journal*, and to commend the editor, Dr. H. R. Lang, and the advisory committee for their continued meritorious efforts.

All but one of the twelve monthly issues have contained one or more special articles or special reports, in addition to the several original contributions, reviews of new books and notes and comments. Scientific education, environmental warmth and human comfort, the 1948 revision of the international temperature scale, and electrical conduction in glass are the subjects of the four special articles, and the special reports consist of summaries of the proceedings of various conferences and discussions held by branches of the Institute during the past two years. It is impossible to summarize adequately the various original contributions. They range over a wide field covering electronics, vacuum technology, photoelasticity, rheology and glass technology. Only one of the contributions, "An Electromagnetic Problem", by Dr. G. F. C. Searle (p. 268), seems to be out of place in a periodical devoted solely to applied physics, but the editor may be excused for this apparent lapse because the problem discussed is of considerable fundamental interest. It arose when preparations for the celebration of the centenary of Heaviside's birth reminded that veteran of experimental physics, Dr. Searle, that, in 1916, he sent an electromagnetic problem to Heaviside for solution but which, apparently, Heaviside either could not solve or merely ignored. The original problem presents great mathematical difficulties; but, in his article, Dr. Searle considers a simplified case which he then proceeds to solve in an elegant manner. Perhaps some physicist may now be prompted to tackle the more difficult problem submitted to Heaviside.

The illustrations, index and binding of this first volume are of a high standard, and the large clear type is particularly welcome. It is to be hoped that proper and adequate support will be forthcoming from members of the Institute, industrial organizations and professional societies for the *Journal* to continue as a medium for bridging the gap between applied physics in the laboratory and its eventual translation into industrial practice.

S. WEINTROUB

Light and Sound

By M. Nelkon. Pp. viii+342+2 plates. (London: William Heinemann, Ltd., 1950.) 11*s.* 6*d.*

IN view of the number of text-books of intermediate standard already in existence, the value of yet another is rather doubtful, and it could only be justified by some particularly original treatment and ideas. In this book, however, the treatment throughout is conventional.

University teachers will also note with regret that the author uses the 'real-is-positive' sign convention in light, thus helping further to establish its hold at the school level of teaching. This convention, since it is not easily extended to non-axial points, is of little use in degree courses, and thus a definite cleavage now exists between the teaching of optics in the schools and the universities. The author admits this difficulty, and gives an introduction to the 'new Cartesian' convention in an appendix. Since this convention was recommended in 1934 by a committee appointed by the Physical Society, it is a matter for regret that it is not more widely adopted.

Applied Mycology and Bacteriology

Originally compiled by L. D. Galloway and Dr. R. Burgess. (Modern Chemical Industries Series.) Third edition, revised by L. D. Galloway. Pp. viii+184+8 plates. (London: Leonard Hill, Ltd., 1950.) 12*s.* net.

MANY workers in mycology and bacteriology will already know this book from earlier editions. It is perhaps most valuable as a general introduction to methods of work and to the techniques of handling and control of micro-organisms. Part 1 deals with such questions, and includes several modern contributions. Part 2 is a wide review of the ways in which fungi and bacteria are connected with industry, medicine and food. There is here not sufficient detail for the specialist, who may, nevertheless, be able to glean one or two ideas from other fields of action. The section serves as a very good introduction for the student or laboratory worker, and it makes interesting reading. Mr. L. D. Galloway has considerably re-written the text for this third edition, and the ten illustrations are so good that more would be acceptable. JOHN GRAINGER

INFLUENCES OF TIDAL STREAMS ON OCEANOGRAPHIC AND CLIMATIC CONDITIONS IN THE SEA AS EXEMPLIFIED BY THE ENGLISH CHANNEL

By Dr. G. DIETRICH
German Hydrographic Institute, Hamburg

In so far as a periodically recurring wave process is linked up with friction and eddy viscosity, it can well exercise permanent influences in the sea. In the case of tidal streams, various effects of this kind can be observed. Being closely associated with tidal waves which are very long compared with the depth of the water, the tidal streams reach right down to the bottom of the sea, where they are diminished by frictional influences. From hydrodynamics it is well known that, with increasing vertical change of velocity, the eddy viscosity will be intensified if the stability of the layering of the water remains below a certain critical value. Since, in the sea, this limitation is mostly fulfilled, the density stratification will be diminished in the presence of tidal streams. In the case of low speeds, destruction of the density stratification will be confined to the neighbourhood of the sea bottom; at higher velocities, however, the destruction will be intensified until the tidal streams have succeeded in mixing the whole water column from bottom to surface. The occurrence of strong tidal streams is confined to limited parts of the marginal seas where topography favours the development of high tidal waves. Hence, in this type of area, water masses which are in a considerably differentiated stage of mixing may be found within a short distance from each other; this situation facilitates the comparison of the physical effects.

The English Channel is particularly suited for demonstrating the influences of tidal streams. The velocity of these currents reaches high values in this area, and its distribution is well known from a recent paper by W. Hansen[1] summarizing the observations. In addition, the oceanographical and meteorological factors are supported by an abundant and very diversified mass of observational material. References to the material and methods of elaboration of it have been dealt with in another paper[2].

Fig. 1 shows several oceanographical and climatic factors presented for a line which follows the axis of greatest depths and is more or less coincident with the orthodrome from 48° N., 8° W., to 51° N., 1½° E. This line runs from the continental slope in the Bay of Biscay as far as the Straits of Dover. B indicates the topography of the bottom along this line. Some of the factors indicated do not take into consideration the small depression of the Hurd Deep, in order to avoid a one-sided representation. In winter, the whole water column is homogeneous from the surface down to the bottom of the sea, while in summer, in the Bay of Biscay, a characteristic stratification develops. This consists of a homogeneous top layer with high temperatures, and a cool homogeneous subsurface layer. The line T indicates the mean depth of the temperature discontinuity between these two layers in August. The temperature difference Δt between these two layers, corresponding to the temperature difference between the surface and the sea bottom, gives an idea of the magnitude of the temperature discontinuity. In the western entrance of the Channel, abreast of Ouessant, the discontinuity layer rises remarkably from a depth of 45 m. to 20 m. and in the same region Δt falls from about 6° to less than 2° C.

This phenomenon demonstrates the immediate effect of the mixing process caused by tidal streams. Fig. 1 shows that the velocity of the tidal streams V rises from 1 to 2 sea miles/h. (knots) in the same area. Consequent upon the greater vertical turbulence caused by the increased frictional influences near the bottom, the discontinuity layer is carried off from below and hence, as a whole, becomes shallower and less powerful. Towards the central part of the English Channel the tidal streams increase to such an extent as to cause the summer discontinuity to be completely destroyed. Hence, it is not only in winter, but also in summer, that the central and eastern parts of the Channel are thoroughly mixed from the surface down to the bottom. Owing to the shallow depths in the area extending from the Isle of Wight to Dover, the local falling-off of tidal stream speeds does not suffice for the formation of a summer layering there.

As a result of the mixing process enforced by the tidal streams, the quantity of heat available at the sea surface from the heat balance will be imparted to a far thicker water layer than would be the case if there were no tidal mixing process. The heat balance at the surface being limited, the annual variation of the surface temperature will be damped. The annual mean variation of the surface temperature, $t_{Wh}-t_{Wl}$, which in the latitudes concerned normally rises with approach to the Continent, can be seen from Fig. 1 to show a noteworthy decrease abreast of Ouessant in that the maximum annual temperature t_{Wh} falls and the minimum temperature t_{Wl} rises. At the surface, this damping is imparted to the air temperature and, unlike the conditions in the Bay of Biscay and the eastern Channel, there is observed a decrease in the annual variation $t_{Ah}-t_{Al}$ in the western Channel. In taking the annual variation as a measure of continentality—as is customary in climatology—one arrives at the apparently paradoxical conclusion that the open Bay of Biscay has a greater continentality than the adjacent western Channel. This phenomenon is due to the effect of the mixing process caused by tidal streams.

The damping will be manifested not only in a diminution of the mean annual variation of water and air temperatures but will also reveal itself in the mean retardation of phases of the annual variations. To express this in a more illustrative way, it will become evident in the retardation of the setting-in of the annual maxima P_W and P_A. Because of this, the premature occurrence of the maxima normally found in approaching the Continent is decisively disturbed. In the central Channel abreast of Guernsey, the P_W values are delayed until September 11, the corresponding date in the Bay of Biscay being August 20. The maxima of the air temperatures are much less delayed, namely, by five days. The maximum is retarded until August 17, as compared with August 12 in the western approaches to the Channel. The noticeable increase in the phase difference between the annual variations of water and air temperatures, as shown in Fig. 1, contributes to the development of extraordinary values of temperature gradient in the air layer near the water

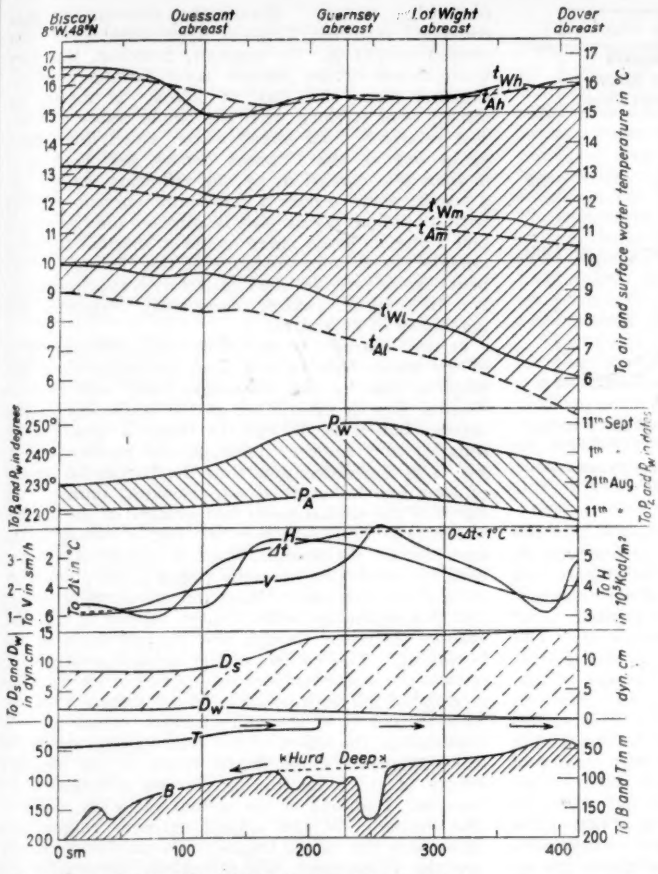

Fig. 1. Some oceanographic and climatic elements in the English Channel along the line following the axis of greatest depth (nearly the line 48° N., 8° W.–51° N., 1½° E.)

B, Bottom topography in metres.
T, Depths of the thermal discontinuity layer in summer in metres.
Δt, Difference of water temperature surface minus bottom in summer in °C. (intensity of discontinuity later).
→, Observed main direction of sea currents.
D_S, Mean geopotential topography of the sea-surface relative to the 100-decibar surface in dyn. cm. in summer.
D_W, Mean geopotential topography of the sea-surface relative to the 100-decibar surface in dyn. cm. in winter.
////, Mean annual variation of geopotential topography D_S–D_W.
H, Annual variation of heat content in 10^5 k.cal./m.².
V, Mean maximal spring velocity of tidal streams in sm./h. (knots).
P_A, Phase in degrees of cosine wave or in dates of setting-in of max. temperature of the mean annual variation of air temperature.
P_W, Phase in degrees of cosine wave or in dates of setting-in of max. temperature of the mean annual variation of surface water temperature.
\\\\, Phase difference P_W–P_A in degrees or days.
t_{Am}, Annual mean air temperature in °C.
t_{Ah}, Maximal mean air temperature in °C.
t_{Al}, Minimal mean air temperature in °C.
t_{Wm}, Annual mean surface water temperature in °C.
t_{Wh}, Maximal mean surface water temperature in °C.
t_{Wl}, Minimal mean surface water temperature in °C.
////, Annual variation of air temperature in °C.
////, Annual variation of surface water temperature in °C.

surface. In early summer, at the time of the greatest rise in temperature, the water in the central part of the Channel is considerably cooler than the air, whereas in late autumn, at the time of the greatest fall in temperature, the water is considerably warmer than the air. In consequence, the meteorological conditions essential for the formation of fog and mist are produced in early summer, while, on the other hand, the formation of fog and mist will be rendered more difficult in late autumn. From the observations recorded in Fig. 2, this is impressively confirmed. The lighthouses Les Hanois and Casquets are at open places in the central part of the Channel, Les Hanois west of Guernsey, and Casquets west of Alderney. In order to establish a comparison, reference has been made to the hours of fog at the Seven Stones light-vessel near the Scilly Isles. Unlike the observations in the central part of the Channel, they show an unimportant annual variation. In the Channel there is an unusual abundance of fog in June/July—involving various dangers for shipping—and an extraordinary absence of fog in October/December. This climatic peculiarity of the Channel is seen to be attributable to the influence of the mixing process of the tidal streams.

The effect brought about by the tidal mixing process, however, accounts for a part only of the anomalous conditions. This becomes particularly evident when the annual variation of heat content in the sea is considered. Curve *H* in Fig. 1 indicates the quantity of heat in 10^5 k.cal./m.² stored up from the time of minimum heat content in winter until the time of maximum heat content in summer, and relates to the compensated bottom topography *B* without taking account of the Hurd Deep. In the western part of the English Channel, this curve rises from 3 to 5·5 × 10^5 k.cal./m.², and over most of the Channel it maintains a value of more than 4 × 10^5 k.cal./m.². These values are not confined to the longitudinal direction indicated in the diagram but extend over the major part of the width of the Channel.

That the situation is unusual will become evident when the components of the heat balance are studied. In Fig. 3 their complete annual variation at the western entrance and in the central part of the Channel is represented; the appropriate calculations were based on methods developed by H. U. Sverdrup[3] and F. Albrecht[4]. The expression is $Q_z = Q_s - Q_b - Q_c - Q_e$ (the legend of Fig. 3 explains these symbols). At the western end of the Channel the quantity of heat which is needed to explain the observed course of temperature throughout the water column down to a depth of 140 m. (Q_t) attains a comparatively close approximation to the local heat balance between ocean and atmosphere (Q_z). The differences between Q_t and Q_z may be conditioned by both the horizontal turbulence of heat and the annual variation of the course of the current. In the central Channel, on the other hand, where Q_t refers to 0–80 m., it is considerably greater than Q_z. The paradox thus occurs that the increase in heat content Q_t is greater than permitted by the radiation of the sun and the sky Q_s. Furthermore, a comparison between the two diagrams in Fig. 3 shows that the values of the vertical heat balance Q_z differ markedly between the

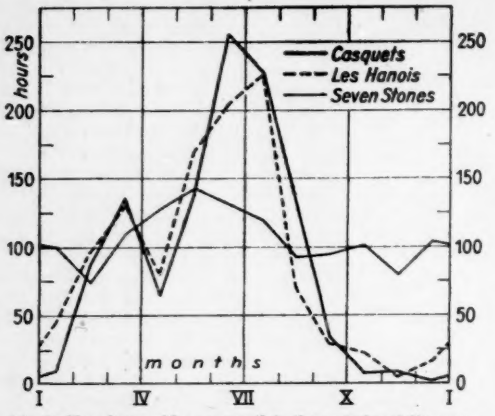

Fig. 2. Mean hours of fog per month in the central part (Casquets and Les Hanois) and in the western entrance (Seven Stones) of the English Channel
(Casquets Lighthouse, 49° 43′ N., 2° 33′ W.; Les Hanois Lighthouse, 49° 26′ N., 2° 42′ W.; Seven Stones Light Vessel, 50° 04′ N., 6° 05′ W.)

two areas. In the central part of the Channel the water receives more heat from the atmosphere in spring and summer than it does at the western end of the Channel, which is, above all, due to the fact that the evaporation heat Q_e remains small. The evaporation heat saved helps to increase Q_z. The unimportant degree of evaporation in the central Channel, as well as the frequent occurrence of fog, are conditioned by the negative difference between water temperature and air temperature. This, as has already been shown, is closely related to the mixing process of the tidal streams. These high values of Q_z cannot, however, sufficiently explain the observed variation of temperature as shown by Q_t; also, the horizontal eddy conductivity of heat is of little avail in this connexion. The horizontal temperature differences remain unimportant, and there are no extensive areas of shallow water as in the Irish Sea. There the shallows contribute very warm water in summer and cool water in winter by way of a horizontal eddy conductivity; in so doing they further the heat exchange in the Irish Sea, as has been shown by K. F. Bowden[6].

The combined effect of water balance and tidal mixing in the Channel is expected to help greatly in unveiling the causes of the anomalous value Q_t in Fig. 3, and of curve H in Fig. 1. From numerous current observations by J. N. Carruthers[6], it is well known that a current flows in a west–easterly direction through the upper layers of the Channel. Yet only a small proportion of the water entering the Channel passes the Straits of Dover; the major portion of it leaves again at the western end. Observations made by J. N. Carruthers[7] and H. W. Harvey[8] with a system of drift bottles on the sea bottom support these views. The arrows in Fig. 1 show this circulation system.

In winter, this type of water balance does not exert any essential influence on the heat balance. The water is then isothermal from the surface down to the bottom, and the inflowing water has equal or similar temperatures to the outflowing water. Hence the amount of heat conveyed into the Channel approximates to that carried out of it. In summer, however, the very warm water of the surface layer flowing into the Channel from the Bay of Biscay is mixed by strong tidal streams with the whole water column. The relatively cool mixed water which flows back again out of the Channel carries less heat with it than was carried in by the inflowing water. As a result, there occurs a horizontal current of heat with an annual period that is effective only in spring and summer, when there exists a thermal layering outside the western entrance of the Channel. This heat current provides the Channel with approximately 2×10^{15} k.cal., which sufficiently explains the anomalies of H and Q_t.

It need scarcely be said that this combined effect of the water balance and tidal mixing process also plays a part in the oceanographical and meteorological factors mentioned at the beginning of this article, but it is difficult to make a quantitative separation. Another phenomenon represented in Fig. 1 is elucidated now that the horizontal supply of heat has been taken into account, namely, the curve of the annual mean temperature of the surface water, t_{Wm}. This falls from the Bay of Biscay to the area abreast of Ouessant, which is in good agreement with the conditions normally ruling in the neighbourhood of the Continent. Next follows an unimportant rise in temperature with, finally, farther to the east, another decrease, though less marked than at the beginning. The course of the air temperature t_{Am} reflects the water-temperature curve but shows a less modulated fall with progress to the eastern Channel. This behaviour of the annual mean values may be regarded as the effect of the heat supply, which, as was explained before, is the result of the conjoint effects of the tidal mixing process and the water balance. Damping of the annual variation, delay in the setting-in of the annual extreme values, and increase in the annual means of the air temperatures, are the phenomena which entirely determine the favourable climatic conditions in the Channel. These could not possibly occur in this form did not the mixing caused by the tidal streams exercise its influence.

In addition, the high annual variation of the heat content in the Channel exercises influences of an especially oceanographic character, as a result of which the specific volume of the whole water column

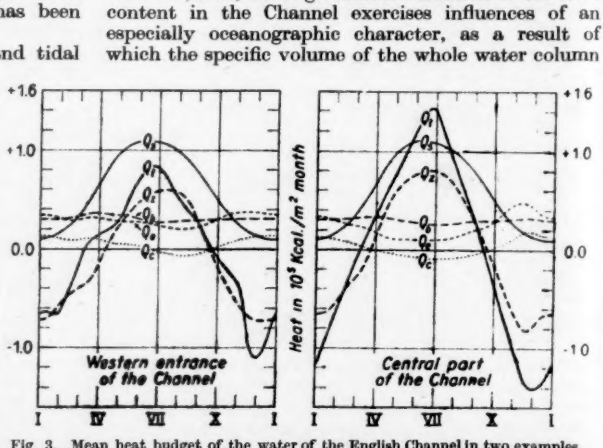

Fig. 3. Mean heat budget of the water of the English Channel in two examples. Q_s, heat absorbed from incoming radiation from sun and sky; Q_b, heat lost by back radiation from the sea surface; Q_c, heat lost by convection of sensible heat to the atmosphere; Q_e, heat lost by evaporation; Q_z, heat balance in vertical direction: $Q_z = Q_s - Q_b - Q_c - Q_e$; Q_t, heat used for explaining the observed annual temperature variation of the water from surface to bottom

inside the Channel has a higher annual variation than that of the area outside. It follows that the geopotential topography of the sea surface is subject to greater changes in the course of a year. D_S in Fig. 1 indicates its situation in summer, and D_W in winter. Both are referred to the 100-decibar surface. $D_S - D_W$, which amounts to 6 dyn. cm. outside the western end of the Channel, reaches 13 dyn. cm. in the central part of the Channel. From this it follows that there is a change in the gradient of the geopotential topography, especially in the section Ouessant/Guernsey, as can be seen in Fig. 1. The increase of D_S and the concurrence of the Coriolis forces provoke a cyclonic component of motion superimposed on the general drift current and driving the inflow towards Brittany, and the outflow towards Cornwall. In winter, the situation is reversed; then, the decrease of D_W contributes to the formation of an anticyclonic component of motion, which drives the inflow towards Cornwall and the outflow towards Brittany. Observation confirms this annual change in the circulation system of the water masses. According to the monthly charts of surface salinity by J. R. Lumby[9], the tongue of water of high salinity and reaching from the Bay of Biscay to the western Channel advances as far as Brittany in summer and as far as Cornwall in winter. The low-salinity water of the Bay of St. Malo, urged by the anticyclonic component of motion, advances in winter to the west beyond Ouessant; in summer, on the other hand, the cyclonic component of motion drives it back into the inner part of the Bay of St. Malo.

A series of causal relations could be quoted which, in the end, could all be traced back to the effect of the tidal mixing process. This may be expected to prevail similarly in other areas having pronounced tidal streams, such as the Irish Sea, the Minch Channel, the waters north of Scotland, and the southern North Sea, where the effect of the tidal mixing process on the layering of the water has been proved[10]. Thanks to the large and varied mass of observations available, the English Channel appeared to be particularly well suited for demonstrating the influences which tidal streams exert on oceanographic and climatic conditions.

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[2] Dietrich, G., *Deutsch. Hydr. Z.*, **3**, 184 (1950).
[3] Sverdrup, H. U., *Ann. Hydr. Marit. Met.*, **64**, 41 (1936).
[4] Albrecht, F., *Reichsamt Wettard. Wiss. Abh.*, **8** (Berlin, 1940).
[5] Bowden, K. F., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **5**, 270 (1948).
[6] Carruthers, J. N., *J. Mar. Biol. Assoc.*, N.S., **17** (1930); *Fish. Invest.*, (II), **11** (1928); **14** (1935).
[7] Carruthers, . . N., *J. Mar. Biol. Assoc.*, N.S., **14** (1927).
[8] Harvey, H. W., *Cons. Int. Exp. Mer, Rapp. Proc. verb.*, **37** (1925).
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[10] Dietrich, G., *Kiel Meeresf.*, **7**, 35 (1950).

STRUCTURE OF CLATHRATE COMPOUNDS*

By H. M. FOWELL

Chemical Crystallography Laboratory, University of Oxford

THAT certain of the chemical elements will unite together to form new substances, their chemical compounds, is well known and to some extent explained. It is also known that a compound capable of a separate existence of its own may combine with an element and that two such compounds may unite by simple addition: $L + M \rightarrow L.M$.

* Substance of a Friday Evening Discourse entitled "Atoms Encaged —A New Type of Compound" delivered on April 28.

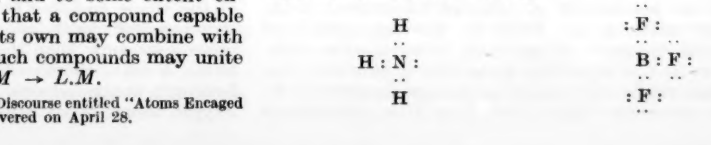
Some time ago, the conviction formed that the ordinary manifestations of these interactions between old substances to form new are the outward signs of inner rearrangements of atoms that make up the invisibly small units of both old and new. Since it became apparent that atoms are not the indivisible units that their name states them to be, the explanation for the bonding of one with another has been sought in the interaction of their component parts. The essentially electrical structure of the atom with some of the pieces positively or negatively charged has been demonstrated, and, since similar charges repel each other and dissimilar charges are mutually attracting, the supposition arose that these interactions could cause atoms to hold together.

Although the law of force between charges is simple, its application to the whole complex system of electrical charges in uniting atoms is difficult, and the problem is for the most part treated by approximate methods. The linkage of atoms is related to the disturbances of a few of their negatively charged electrons, which are sometimes spoken of as being farther than others from the centre of the atom. These electrons are less firmly bound to the positive nucleus than some of the inner ones which partly screen them from the nuclear charge, and in a complex atom they form only a small part of the whole. Their rearrangements by transference from one atom to another or sharing between them provide the binding forces.

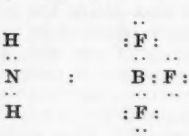
Certain groupings of electrons, notably a completed outer group of eight, are particularly stable. This is illustrated by the known sequence of atoms according to the number of electrons surrounding the nucleus. Atoms, which in the uncombined state already have the stable configurations, have no chemistry; they are the so-called inert gases, helium, neon, argon, krypton, xenon and emanation, and they are commonly stated to form no compounds; their electrons do not need any rearrangement. Much of the simpler chemistry of the neighbouring atoms in the atomic number sequence is interpreted as the rearranging of their electrons to form similar stable groups around atoms which in their uncombined state do not have them.

When transference of an electron takes place, the atoms become positively or negatively charged, according to their loss or gain of electrons, and the resulting ions are mutually attracted, as are other oppositely charged bodies. Atoms may complete the desired stable groups by sharing what they have when one or both are deficient in electrons.

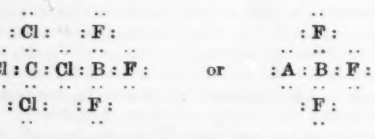
When a particular atom has a stated set of electrons, and some of the outer ones are shared to form two or more bonds, the directions in space of the bonds relative to each other are fixed. They adopt one or other of a number of known patterns, and from this they vary little, whatever may be the nature of the groups that they bind to the atoms concerned. Electron sharing usually results in the build-up of some familiar stable group; but even when the more urgent electronic requirements of combining atoms have been satisfied, and a stable compound formed, there remain further possibilities of combination. For example, of the molecules of ammonia (NH_3) and boron trifluoride (BF_3),



the former has for all atoms an inert gas electronic arrangement which is helium-like for hydrogen, neon-like for nitrogen; in the latter, the group of six electrons around the boron atom is stable, but it can be increased to eight by addition of NH_3 to give:



If the paper drawings of electronic dots alone were needed, this process could be extended: for example,



But these atomic linkages do not take place. Such compounds of argon and boron trifluoride were reported, but their existence has been disproved. This form of sharing does not happen because too much energy is required to make argon or even xenon give up a share of its electrons.

A further type of linking, which causes the union of molecules, is known as the hydrogen bond. For the present purpose it is sufficient to say that it forms only between a few groups, commonly between hydroxyl (OH) groups, and although not so precisely limited in space arrangements, the directions of hydrogen bonds are restricted in a manner analogous to that of the electron-pair bonds.

For some substances formed by the addition process $L + M \rightarrow L.M$, it is inevitable that for a time there should be a meaningless full stop inserted between L and M; it must be emphasized that this does not represent an electron. Although many addition compounds are eventually fitted into the known scheme of interatomic bonding, there exist many crystalline molecular compounds for which no formulation is apparent, and the suspicion arises that between the molecules there is no chemical binding of any of the kinds already described.

These associations of molecules are attributable to parts of the total interatomic forces so far neglected. Between all molecules, additional, usually much weaker, forces come into play. They arise because the centres of positive and negative charges do not at all times coincide. Some molecules have permanent, some transient, dipoles or multipoles. There is a more restricted use of the term, but for convenience, all these residual attractions may be grouped together and called van der Waals forces. As a result of their operation, a multitude of substances draw their electrically neutral molecules together into crystalline forms. These forces are strong enough to hold atoms of the non-combining inert gases in crystal structures that exist at suitable low temperatures.

In a mixture of molecules, it happens, fortunately, that all those of one kind will often gather together. From an assortment of different molecules, stable regular patterns are built by the segregation of identical shapes. Sometimes, however, two substances do not crystallize separately in this way, but together make a crystalline molecular compound. In these structures, which often bear little resemblance to those of the components when they crystallize in the pure state, there are no links between the two kinds of molecules. This is shown by the observed interatomic distances, which are much greater than those commonly found between linked atoms. As an example, there is a molecular compound of *p*-iodoaniline with *s*-trinitrobenzene, one molecule of each. The two kinds of molecules pack together according to a regular repeating space pattern similar to those formed by single pure substances.

In other molecular compounds there is the same co-operation of the two components, but in some series the structural arrangements of one component dominate the whole. Thus if a paraffin is added to a saturated solution of urea in methanol, a crystalline compound is formed immediately. It consists of urea molecules arranged so as to form a structure resembling a honeycomb. In the long channels of the honeycomb the paraffin molecules are located, and if molecules of different lengths are used, different ratios of urea to paraffin are found. In general, they are not whole-number ratios and the formula is nUrea.H, where n is proportional to the length of the hydrocarbon molecule H.

In these uniting pairs, one partner at least is a solid when pure at ordinary temperature, at which the molecular compounds are prepared. The other is a solid or liquid. Sometimes, especially if one participant is a very volatile liquid, the molecular compound decomposes when allowed to stand in the open. A substance with van der Waals forces between its molecules so weak that it is normally a gas is therefore not likely to form similar compounds.

But a hundred and two years ago Wöhler prepared an addition compound of quinol and sulphur dioxide. He gave the composition as $3C_6H_4(OH)_2.SO_2$, and reported that it did not lose the normally gaseous sulphur dioxide on standing, but that on solution the sulphur dioxide was lost and quinol recovered. During the next sixty years, similar compounds were obtained with quinol, and a second substance such as hydrogen sulphide, hydrogen chloride, hydrogen bromide, hydrogen cyanide or formic acid. In some, the ratio of the second substance to quinol is less than 1 : 3. This is also the case with some recently added members of the series (acetylene and carbon dioxide); but others (for example, methanol and methyl cyanide) reach the 1 : 3 ratio, which is never exceeded.

There being none of the bonds mentioned earlier and, for the most volatile of these second components, no great van der Waals attractions between the components, how can these crystalline compounds exist? Why at ordinary temperatures have they no significant dissociation? What accounts for the unusual 1 : 3 ratio and its variations, and on what basis does quinol choose certain companion molecules and reject others? How, in the series that starts with water (HOH) and passes through methanol (CH_3OH), ethanol (C_2H_5OH) to the higher alcohols, is methanol alone singled out for such combination?

Application of the very penetrating method of X-ray crystal structure analysis has provided the answers. By this method the positions of all atoms in the crystal array are accurately found. Quinol molecules of the shape and size expected are revealed in the structure sufficiently separated from the other component to show that there is no chemical bonding to it. A set of these molecules link together through hydrogen bonds between their hydroxyl groups. Six oxygen atoms of six different quinol molecules form

a plane hexagon. Alternate quinol molecules incline upwards or downwards from this and are linked in a similar manner through their other hydroxyl group to form a structure of the giant molecule type. This structure may be likened to the steel frame of a large building. Each girder represents a quinol molecule, and the points where six such girders meet should be replaced by a hexagon to correspond with the hydrogen-bonded hexagons. Two identical frames of this kind form and interpenetrate. They are in no way linked by chemical bonds, but are inseparable without the breaking of chemical links. This arrangement may be seen as two identical steel frames, not joined, but arranged such that the junctions of girders in one are at the centres of the rooms in the other.

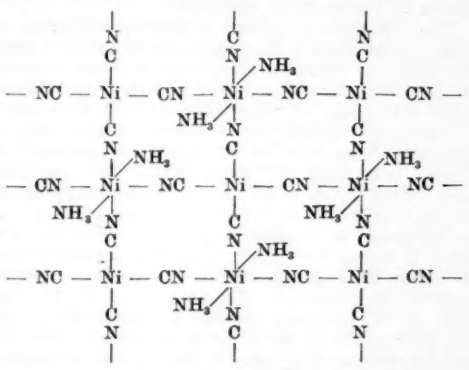
The double quinol structure is still not a very close-packed one, and between the two giant molecules there is a set of cavities, each a roughly spherical empty space of about 4 A. diameter. In these spaces reside the molecules of sulphur dioxide or other substances which form these molecular compounds. The molecule once trapped in this space cannot escape. As it approaches the walls of its cage, large forces of repulsion between it and the walls are set up. There are no holes in the surrounding structure large enough for it to escape without coming much closer than the normal van der Waals contact distance to the atoms of the quinol molecules. The structure is different from that formed by quinol itself in the absence of any molecules suitable for enclosure. Every gas molecule has one of the set of identical molecular envelopes around it. Although there will always be van der Waals forces of attraction between the cage and its occupant, these forces, which in any case are insufficient to do it, are not necessary to ensure the permanent association of the two substances. The sulphur dioxide can be released by heating, but only as a result of the breaking of the hydrogen bonds, and sublimation of quinol. Similarly, it is released when the material is dissolved in any solvent for quinol.

The chemistry of such compounds now becomes clear. There are three molecules of quinol in the material of the cage structure for every cavity formed. This explains the formula *M*.3 (quinol). It is a limiting composition, since some cages may be left empty. The selection of molecules that take part in the compound formation now loses its miscellaneous character. The enclosed molecule must be small enough to go into the space available and large enough not to escape through the available holes, the largest of which is the hexagon of oxygen atoms bound by hydrogen bonds. For this reason methyl cyanide (CH_3CN), methanol (CH_3OH), acetylene (C_2H_2) and carbon dioxide (CO_2) seemed possible participants, and proved to be so. Ethanol (C_2H_5OH) is too large; water (H_2O) is too small. The compounds with argon, krypton and xenon have been prepared by crystallizing quinol solutions in the presence of the inert gases, which are used at suitable pressures to increase the solubility. The pressures need not be very high, and if other conditions are properly controlled the argon compound can be made at 10 atmospheres or less. The products consist of crystals often a centimetre across and easily distinguishable from ordinary quinol.

Although it seems likely that many such enclosure compounds may exist, it is difficult to predict which pairs of substances will form them; but if a compound which is already known belongs to this class, there are characteristics by which it may be provisionally detected.

The series of compounds formed from ammoniacal nickel cyanide solution and a small group of organic substances provides an example. The composition is $Ni(CN)_2.NH_3.M$, where *M* is benzene, thiophene, furan, pyrrole, aniline or phenol. There is no obvious manner in which benzene may be linked to the nickel cyanide complex. The metal —C≡N— metal sequence of atoms, which may well be suspected in the cyanide complex, is a suitable cage-forming component. Homologues of benzene and of the other molecules do not form such compounds. The thiophene compound has only about a third of the thiophene indicated by the formula.

Examination by X-ray methods of the crystalline benzene compound shows that the main component of the structure is an extended two-dimensional array of groups which form a flat network:



To every other nickel atom there are attached two ammonia groups projecting above and below the network. One set of nickel atoms is surrounded by four carbon atoms in a square pattern, and the other by four nitrogen atoms of CN groups, and two ammonia groups, the six nitrogen atoms forming an octahedron.

This complex has a rigid flat structure with projecting ammonia groups which prevent the close approach of two layers. Although staggering of the projecting ammonias would make possible a closer packing, no arrangement can avoid a considerable amount of empty space. By the inclusion of a benzene molecule in each of a set of cavities left between layers, there results a structure which, as a whole, is well packed. All the molecules which are capable of combining in this way have shapes and sizes very similar to those of benzene.

The behaviour of these compounds may be applied in the chemical processes of separation, identification and quantitative analyses. They provide new and striking ways of preparing pure materials. The ordinary methods of fractionation lead to products which are likely to contain impurities of very similar physical properties to the desired substance. Further separation, for example, of two isomeric hydrocarbons of almost identical boiling point, can be extremely difficult. It is precisely at this stage of difficulty that a method of separation based on some entirely different factor is required. Two substances of such close similarity of physical properties may yet differ strikingly in the geometrical form of their molecules. Thus a paraffin may be of the straight-

chain or branched-chain type. These may be separated by use of the urea compounds, because the straight chains fit into the honeycomb whereas the branched isomers cannot; but the separation of chains of different length is not a structural necessity. In clathrates, as these compounds are termed, the cage is of restricted size and, if suitable structures can be found, molecules of different lengths should be separable.

Benzene which is already of reasonable purity may be further rid of impurities, probably *cyclo*hexane, by formation of its nickel cyanide ammonia complex, which is later decomposed. A single crystallization of this kind gave a large yield of benzene, which contained 99·992 ± 0·004 molecules per cent. The ideal in this type of chemical work should be to 'tailor a suit' for any desired molecule, which could then be obtained as a molecular compound; this compound could then be removed as unwanted or used as a source of the required material.

The purification process is further illustrated by some experiments in the separation of the inert gases. No ordinary chemical compounds of these elements are available for a separation, and the usual method takes advantage of their different boiling points in a fractional distillation process. Argon may be separated from neon by adjusting the pressure conditions such that the argon forms the compound with quinol but neon does not. The gases krypton and xenon, which both form compounds with quinol, may be separated in a different manner. Since the solubility is higher for xenon, there is a greater chance for xenon to become enclosed. A mixture containing krypton and xenon in the proportions of 3 : 1 was used in the standard method of preparation; the gas liberated from the crystals contained about one part by volume of krypton to three parts of xenon.

ENGINEERING EDUCATION AND TRAINING

THERE has been much controversy in recent years on the education of the engineer. An unusual feature of the discussions is that engineers have taken relatively little part. That this is not due to lack of interest in the subject is shown by the fact that during the Joint Engineering Conference held during June 4–15 in London, a whole day was devoted to papers dealing with the education and training of the engineer.

During the morning of June 13, at the Institution of Civil Engineers, Prof. J. F. Baker read a paper on "The Development and Trend of University Education in Engineering", and this was followed by "The Contribution of the British Technical Colleges to Engineering Education", by Dr. H. L. Haslegrave. As was to be expected at a Conference having as one of its objectives the recording of the contributions made during the past century by engineers to the advancement of civilization, both authors devoted considerable attention to the history of technical education in Great Britain.

While the origins of the technical colleges in Great Britain go farther back than a hundred years, to a welfare movement for working men and neglected youths and to the founding of the Society of Arts in 1754, the universities, in all but one of which there are now flourishing engineering schools, came into the field much later. It was not until a third of the nineteenth century had passed that courses of lectures, described as "Civil Engineering", were given in the University of Durham and in University College and King's College, London, and not until 1840 was any real attempt made to establish a balanced course of fundamental science and practical application.

In 1851 there existed only five university schools of engineering in Britain, chairs having been established at Glasgow, Dublin and Belfast, while the courses at Durham had been wound up. In the next twenty-five years four more were added, Owens College, Manchester, and Armstrong College, Newcastle upon Tyne, being founded, while the Universities of Edinburgh and Cambridge established chairs of engineering. It was shortly after this, between 1878 and 1890, that the most striking blossoming of advanced educational facilities occurred; no less than nine chairs of engineering being established in this period. In almost all cases the colleges owed these foundations to the generosity and ideals of local men; but they all had financial difficulties. More serious was the dual part all but Cambridge were called upon to play; the Government Department of Science and Arts instituted in 1858 having provided by means of grants a great stimulus for skilled craftsmen to attend evening classes, all other schools were centres of evening as well as day work. While the evening class students undoubtedly brought in that enthusiasm which is still so marked in the technical colleges, the dual responsibilities inevitably had repercussions on research and scholarship in the universities. Only gradually were the two activities separated and, in fact, in several cases this separation has still to be effected.

During 1900–14 the story of engineering in the universities is one of continuous and steady development, although hampered by lack of funds in spite of State aid. As in other fields, the First World War had appreciable repercussions. Apart from the sharp rise in numbers, the main effect seems to have been indirectly through changes in industry, which at last realized the advantages to be gained from the application of science to production and design problems. More universities stiffened their courses to three years post-intermediate and delayed specialization until the final year; but only Oxford and Cambridge persisted in giving an all-embracing course to a high level in the firm belief that their products possess a versatility and balance of mind which enable them to strike out with equal facility along any line they may be called upon to pursue.

The most striking change brought about by the Second World War was the doubling of the number of students, an expansion which must at least be maintained if the universities are to shoulder the responsibility of supplying the 'engineer-scientists' and development engineers needed by industry. There is evidence that the universities are alive to their responsibilities and are responding to them with a flexibility which a study of the last thirty years would scarcely lead one to expect. A number of universities are questioning the value of the formal experiments in the laboratory courses and are introducing small investigations and projects in the final year as a means of encouraging initiative and a methodical approach to new problems. Alarm at the inability of students to think and write logically has led in some colleges to formal instruction in the presentation of technical information, and in others

to the use of discussion-groups; and there are other healthy signs of encouragement to undergraduates to achieve a better general education.

While all this development was taking place in Great Britain in the universities, where students get their education in the relatively easy way, the determination of the workers in industry to improve their knowledge of their work brought about an even more striking increase in the number of technical colleges. These were created from the earlier mechanics institutes from 1870 onwards, first by means of voluntary effort and later with government financial help. Evening classes were not the only activity; by 1914 there was a considerable volume of part-time day release of engineering apprentices throughout Great Britain, and this was increased after the First World War when the National Certificate scheme was born. One of the values of this scheme is its flexibility, and the syllabuses, subjects and standards have since been kept constantly under review by the Ministry of Education, the professional engineering institutions and the staffs of the colleges. Teaching of a high order has been assured for part-time students, resulting in the securing of recognized qualifications and through them of membership of the professional institutions. When the output of engineering graduates in Britain is compared unfavourably with those of other countries, the products of our senior technical colleges, which have no parallel abroad, are too often forgotten.

Since 1931 many new colleges have been erected; but this expansion has always lagged well behind the needs of industry. Since the War, two of the Percy Committee recommendations have been adopted, namely, the formation of national colleges, four of which are now in existence, and the setting up of regional advisory councils for further education. These councils have had little time to make any impression other than the production of the controversial scheme for the creation of a Royal College of Technologists. What is likely to have a greater effect upon the progress of technical colleges is the revision of salary scales which came into effect on April 1 last. Up to now the staffs of the colleges have worked with a surprising devotion and resourcefulness for woefully inadequate salaries.

In introducing his paper, Prof. Baker directed attention to a most important recent development in university education, namely, the establishment of postgraduate courses of instruction which generous help from the University Grants Committee has made possible at Birmingham, Cambridge, Edinburgh, Glasgow, the Imperial College of Science and Technology, Leeds and Sheffield. These courses have been designed for engineers whose experience in industry has concentrated their attention on relatively narrow fields. The student will choose that university which has organized a course in the particular field of his interest, and there he will return, not to do research but to attend advanced lectures, to read under supervision and to engage in laboratory work under conditions not generally available in industry and, above all, to learn how to apply science. This scheme should have far-reaching effects, integrating as it does teaching and research activities. Primarily in the interests of the undergraduate courses, the teachers engage in research or consulting work. When that makes them leaders in their particular field, they obtain extra facilities to enable them to organize postgraduate courses of instruction. The students attending these will be mature men coming straight from industry. They will contribute quite as much as they receive, so that the departments' research and undergraduate teaching will both benefit; neither will become too academic and a healthy balanced state will develop.

In the discussion that followed, in which engineers from Holland, Belgium, Australia and New Zealand joined, this scheme was applauded. Its economy over the possible alternative of extending the undergraduate course for a fourth year was stressed, and it was welcomed for its encouragement to make the undergraduate course more general. The opinion of the Conference, expressed particularly by Colonel B. H. Leeson, who opened the discussion, and Dr. Livingstone Smith, was solidly in favour of the universities making their undergraduate courses general and fundamental on the present Cambridge pattern. Prof. R. L. Lickley, while in favour of the postgraduate courses, gave the serious warning that, judging from the experience of the National College of Aeronautics, industry would not avail itself of the new opportunities. Others taking part in the discussion urged the need for a study of teaching methods, for more attention to the education of those destined to become managers, for more places in university engineering departments for the good all-round man who is in danger of extinction, and finally a strong plea was made for the granting of greater academic freedom for technical colleges.

The teaching of engineering presents peculiar difficulties compared with other subjects, because it is essentially an applied science, and practice can never be ignored. This side of the problem was dealt with in two more papers, "Practical Training of Civil Engineers" by Mr. H. J. B. Harding, and "Practical Training of Mechanical and Electrical Engineers" by Sir Arthur Fleming. Both authors gave interesting accounts of the evolution of practical training and of the schemes which are now available. Because engineering employment is diverse, no one single scheme can cover adequately the general needs of the whole profession, nor can a single scheme cover the individual needs because the entrance levels to the profession are different. It was interesting that both authors advocated an increase in the facilities for 'sandwich' courses based on works training. Certain institutions, notably the University of Glasgow, so arrange their courses that the students can spend five months at a stretch in or on works. Mr. Harding has had such men working for him. At the end of the five-months period, they leave an unexpected vacuum behind them in the organization. Mr. Harding suggested that selected colleges should establish double-sandwich courses of, say, five and a half months each. The employer could then engage students in pairs, and as each half-year's course ends they could change places so that one is always available. He then somewhat ingenuously stated that, as the total number of students would not increase, no great increase in teaching staff would be required. No university teacher could go on indefinitely teaching for eleven months in the year; but there is something in the scheme where an institution wishes to double the number of students turned out. It would mean doubling the teaching staff—no easy task to-day—but would entail no addition to its buildings, equipment or appreciably to its laboratory staff.

Though Capt. A. M. Holbein, in opening the discussion, was able to say that he detected an awakening of interest among industrial companies as well as

among individuals, and a sense of responsibility for giving an all-round training as was done by the ancient trade guilds, this was not supported by the other contributors to a somewhat disappointing discussion.

The impression left by the papers and their reception was that Great Britain can deal successfully with the education and training of the technician and the general run of professional engineer, the classes who form the backbone of industry. There is a strong partnership between the technical colleges and the engineering industry, and, though there is plenty of room for better equipment and more generous treatment of teachers in the colleges, they are doing good work and will continue to do this and even better so long as they have the determination to develop their own methods and do not ape the universities. The problem industry has not solved is how best to treat the product of the university. No one denies the urgent need for a steady supply of these highly educated men, and everyone at the Conference agreed that the universities in their undergraduate courses should concentrate on the fundamentals of general engineering science; but this is less than half-way to making the men engineers able to use all their talents. Something more is needed than a two-year graduate apprenticeship followed by the usual haphazard and extravagant method of obtaining experience. The only certain way a young man now has of being given a real chance to develop fully is to be born the son of an engineering magnate. This is a restricted class, and unless leaders of industry and the professions are prepared to 'adopt' more young men from the universities rather than just to use them, then fewer and fewer of the best products will turn devotedly to engineering, ignoring the easier paths open to other scientific workers and the attractions of other professions where the training is better organized and the rewards and social standing are higher.

OBITUARIES

Mr. László J. Havas

László Jenő Havas died on June 9 at Colmar, in Alsace, after an operation. He was born in 1885, of Hungarian nationality, and studied at Budapest and at several other universities; he also worked at Rothamsted Experimental Station. He was a man of wide culture, and an excellent linguist. The problem which primarily interested him was the relationship between plant and animal cancer; and many of his publications testify to his interest in tumours and other plant abnormalities induced by *Bacterium tumefaciens* and chemical agents. It is not widely realized that Havas was the first to apply colchicine in such investigations (*Nature*, 139, 371; 1937); and it was while he was in Brussels in A. P. Dustin's laboratory that he discovered the effect of colchicine on cell-division that has had wide repercussions in genetical work. This was announced at the Congress of Anatomists held at Marseilles in March 1937. (An account of early researches with colchicine has been given by J. M. Krythe and S. J. Wellensiek, *Bibliographia Genetica*, 14, No. 1, 1; 1942).

Havas regarded as his principal paper that on the gradual evolution of polyploidy and other changes in *Pelargonium zonale* (*Bull. Acad. Roy. Belgique*, (5), 28, 318; 1942); but with this also he was unfortunate. Published during the German occupation of Belgium, it attracted little notice except from the Nazis, who destroyed all reprints. Havas suffered under two despotisms, and lost all his belongings in Brussels and Budapest, including his library. After the War he found asylum in France and existed precariously on grants; but his Belgian-born widow is left unprovided for. There were no children.

Hugh Nicol.

Dr. I. E. Balaban

Isidore Elkanah Balaban, head of the Pharmaceutical Research Department of the Geigy Company, Ltd., Manchester, was killed on May 23 when he fell between a train and the platform on alighting at London Road Station, Manchester.

Dr. Balaban showed an early aptitude for scientific work. During the First World War, he served with the Manchester Regiment and later the Special Brigade, Royal Engineers. He then returned to the College of Technology, Manchester, and after graduation, became research assistant to Dr. F. L. Pyman. He worked on glyoxalines and took his M.Sc. and Ph.D. degrees. On Pyman's recommendation he secured a temporary post at the National Institute for Medical Research, Hampstead, where he collaborated with Dr. Harold King in problems of chemotherapy involving the preparation of analogues of Bayer 205 and a study of their substantive properties, glyoxalines containing arsenic and gold compounds.

Balaban then entered on an industrial career, joining first of all the staff of May and Baker, Ltd., under Dr. A. J. Ewins, and ten years later he left to take up a post in the research department of Imperial Chemical Industries, Ltd., at Blackley, thus fulfilling a desire to return to his native city. While in Manchester he was awarded the degree of D.Sc., and he joined the Geigy Company, Ltd., in 1941 to develop the pharmaceutical side of the firm's activities. During these years in commercial firms, Balaban published a number of scientific papers, all having a bearing on chemicals of potential use in pharmacy or medicine.

Balaban was a keen worker in the field of medicinal chemistry and avidly kept in touch with all the latest developments. Of unassuming nature, he surprised his most intimate friends by his love of ornithology and horticulture; thus he thought nothing of paying a visit to St. Kilda to see the sea-birds in their natural surroundings. He will long be remembered by his friends and colleagues for his enthusiasm and honesty of purpose, and many will mourn his untimely end.

We regret to announce the following deaths:

Prof. R. St. A. Heathcote, formerly professor of pharmacology in the Welsh National School of Medicine, on May 19, aged sixty-two.

Prof. F. Marguet, *correspondant* for the Section of Geography and Navigation of the Paris Academy of Sciences, and formerly professor of astronomy in the Naval School of Brest, at Villeneuve-Loubet, on June 2, aged seventy-six.

Mr. G. Udny Yule, C.B.E., F.R.S., formerly University lecturer and reader in statistics, University of Cambridge, on June 26, aged eighty.

NEWS and VIEWS

Radio-Astronomy at Manchester : Prof. A. C. B. Lovell, O.B.E.

DR. ALFRED CHARLES BERNARD LOVELL has been appointed to a newly created chair of radio-astronomy in the University of Manchester. Dr. Lovell was born in 1913 and entered the University of Bristol in 1931. In 1936 he was appointed assistant lecturer in the Physics Department at Manchester; he was made lecturer in 1945 and reader in 1948. During the war years, Lovell was occupied with radar research in the Telecommunications Research Establishment, and accompanied this famous institution in its war-time wanderings from Bawdsay via Dundee and Swanage to Malvern. He was particularly concerned with the development and installation of airborne radar in the air force, and his services were recognized by the award of an O.B.E.

Soon after returning to Manchester in 1945, Lovell set up a radar set, on loan from Anti-Aircraft Command, in the courtyard of the University and began an investigation of radar echoes from meteor trails. Soon driven out of the city area by electrical interference, the radar set was transferred to a field at Jodrell Bank in Cheshire, near the University Botanical Station. Five years later, aided by generous financial support from the University and the Department of Scientific and Industrial Research, there has come into being a large and well-equipped research station, with some eighteen research workers engaged in many branches of the new subject of radio-astronomy. The Jodrell Bank Research Station is now, and will remain, an integral part of the Physical Laboratories of the University, of which the director is Prof. P. M. S. Blackett. Together with the pioneer work of J. S. Hey, of the Ministry of Supply Operational Research Station, and of Martin Ryle at Cambridge, radio-astronomy is now in a very flourishing state in Britain. Among the important contributions from Jodrell Bank has been a detailed survey of meteor activity, which led to the discovery of very intense summer showers occurring in daylight and so unobservable by visual means. This work has greatly changed our present picture of meteor activity. The first radar echoes from the aurora borealis stream were made at Jodrell Bank in 1949. Quite recently, radio noise from the Andromeda Nebula has been detected and shown to be of the same order of magnitude compared with visual light as for our galaxy.

Textile Chemistry at Manchester : Mr. F. Scholefield

MR. F. SCHOLEFIELD is retiring from his position as head of the Department of Textile Chemistry in the Manchester College of Technology on reaching the age limit. He was first appointed, as lecturer in textile chemistry, in 1926. Prior to that he had been one of Prof. A. G. Green's first students in the Department of Colour Chemistry and Dyeing at what was then the Yorkshire College, Leeds. After a short period in Read Holliday and Sons, Ltd.'s dyehouse at Turnbridge, he became chemist to Francis Hinde and Sons, Ltd., at Norwich, and then, successively, chief chemist to Henry Ashwell and Co., Ltd., Nottingham, R. P. Lawson and Sons, of Manchester, and in 1912 to Burgess Ledward and Co., and later manager of their dyehouse. At the Manchester College of Technology he initiated the comprehensive work on the action of light on cotton dyed with vat dyes, for which he was awarded the Research Medal for 1928–29 of the Worshipful Company of Dyers. This work has become classical, and his research work was further recognized in 1947 by the award of the Gold Medal of the Society of Dyers and Colourists, of which he is now president, in recognition of his "Exceptional Services to the Society in the advancement of Tinctorial Technology both in theory and practice". Still more recently he has been awarded at the Brighton Conference of the Textile Institute last May the Institute's Medal for distinguished services to the textile industry. Under Mr. Scholefield the Department of Textile Chemistry in the College of Technology has risen to the front rank in both teaching and research, and he leaves it with a reputation in industrial circles that fully justifies its position in the Faculty of Technology of the University of Manchester.

Gold Coast College of Arts, Science and Technology: Appointments

THE Secretary of State for the Colonies (Mr. James Griffiths) has announced the following appointments in the new Gold Coast College of Arts, Science and Technology: Prof. J. P. Andrews, vice-president and professor of physics in University College, Ibadan, Nigeria, to be principal-designate; Mr. R. Pattison, head of the Department of Engineering and Building, South-East Essex Technical College, to be head of the Engineering Department. The Gold Coast College of Arts, Science and Technology is being established at Kumasi, and work is in progress on the permanent buildings. The College is to be an autonomous institution, complementary to the Gold Coast University College, and will provide courses of higher technical education (including engineering) and teacher-training. Two hundred students of the Achimota Teacher Training College and a hundred other students are expected to move to Kumasi to start the new College this month. A sum of £350,000 has been allocated under the Colonial Development and Welfare Acts for capital expenditure on the College—which is likely to be in the region of £2,000,000.

Prof. Andrews, who is forty-nine, was educated at Leyton County High School and Queen Mary College, University of London, where he obtained his B.Sc. in 1921 and D.Sc. in 1931. He has been professor of physics at Ceylon University College and has carried out research on problems of the ionosphere. During 1939–44 Prof. Andrews was head of the Physics Department in Bradford Technical College, and among other duties was responsible for organizing a scheme for training Service personnel in radio. He then became assistant professor of physics in Queen Mary College, University of London, and in 1949 was appointed to University College, Ibadan. Mr. Pattison has been head of the Department of Engineering and Building at the South-East Essex Technical College since 1943. After holding lectureships in mechanical engineering at Birmingham and Leicester Technical Colleges, he was appointed head of the Engineering Department at Burnley Municipal College in 1938, and superintendent of classes to the Board of Industrial Training, Trinidad, in 1940.

Spotlight on Science

THIRTY or more years ago the means of promoting the layman's interest in science took the form of

articles containing details of simple experiments which the layman could carry out at home. To-day, increasing awareness of the social impact of science has changed the nature of popular science journals and now they usually seek to explain not only the mechanics of important scientific discoveries but also their significance for man and society. This is well brought out in a new journal called *Spotlight on Science*, which has been written by Dr. J. Gordon Cook for "the man in the street and his family". The first issue of this journal consists of notes and articles on such topics as bee behaviour, prospecting in Antarctica, high-frequency radio, fluorine, computing machines, mono-sodium glutamate, meteorology, the extraction of elements from sea-water, and the effects of environmental conditions on human beings. Each article is well written and shows that the author has taken considerable pains over the details of his information and the means of making it clear. Nine useful photographs add to the attractiveness of the journal; but these would have been more effective if spread throughout the whole journal rather than concentrated in the first half. Details of the journal may be obtained from the Merrow Publishing Co., Ltd., 23 Ganghill, Guildford, Surrey.

Bollettino dell'Istituto di Alimentazione e Dietologia

The first number of the bulletin of the Institute of Nutrition and Dietetics, Rome, was issued in August 1950 and includes a description of the work that the Institute proposes to undertake (*Bollettino dell'Istituto di Alimentazione e Dietologia*, 1, No. 1, August 1950; pp. 56. 1, No. 2, October 1950; pp. 64. Rome: Editore 'Il Pensiero Scientifico). It appears that the founders of the Institute were fully alive to the ramifications of the subject of nutrition, for the work envisaged ranges from experimental food production to fundamental laboratory studies in physiology and biochemistry, and includes food technology, catering and dietetics in health and disease. The Institute is also to offer courses in nutrition at various levels, intended for medical officers, nurses, teachers, administrators, economists, agriculturalists, catering officers and cooks, and also non-technical courses for the man-in-the-street and the housewife. All these plans are in concordance with the resolutions adopted by the United Nations Food and Agriculture Conference at Hot Springs in 1943 and repeatedly re-emphasized by the Food and Agriculture Organization ever since. If these plans can be adequately carried through, Italy should be able to evolve and maintain a scientific food policy from which her people would derive great benefit. But to what extent this Institute will be able to influence government policy remains to be seen. The first two issues of the bulletin present reports of work already in progress (for example, on protein levels and albumin/globulin ratios in cases of gastric or duodenal ulcers or carcinoma of the digestive tract) and also diet sheets and recipes for therapeutic use. The second issue also includes very full extracts of the publication by the Food and Agriculture Organization on calorie requirements.

Blight-resistance in Potato

Dr. William Black, working at the Scottish Plant Breeding Station, Edinburgh, has produced several potato varieties resistant to attack by blight, *Phytophthora infestans*. He describes, in a recent paper (*Proc. Roy. Soc. Edinburgh*, B, 64, Part 2, No. 10; 1950), the occurrence of three strains, A B and C, of the fungus. Strains B and C are more virulent than the common strain A, from which they probably arose by mutation. Specialized strains of blight may, under test conditions, alter in virulence; but each can be maintained in continuous culture on a host plant to which it is specially adapted, without appreciable change. This mutability of pathogenic fungi is an incubus to the plant breeder; but Dr. Black now reports breeding experiments for resistance to all three strains. The existence of three genes is postulated: *Rb*, conferring resistance to strains A and B; *Rc*, resisting A and C; and *Rbc*, giving resistance to all three. Each gene is independent of the other in producing its effect, and is inherited independently in simple Mendelian fashion, though there is an excess of recessive individuals. The wild species *Solanum demissum* provides the source of resistant genes.

University Education and Subsequent Careers

An excellent pamphlet, "Introduction to a University" (pp. 47; 1951), has been issued by the University of Birmingham and is designed to assist some of those who now have the chance of a university education but have had little opportunity of finding out what are the essentials of such an education. The greater part deals with the various careers open to university graduates in science and the humanities; but the pamphlet starts with a brief account of the main ideas about universities in general at the present time, especially as they relate to the undergraduate. This is followed by some account of the University of Birmingham itself and of undergraduate life at that University. There is a section on qualifications for admission to the University of Birmingham, and some information on salary scales in various careers is appended.

1950 Conference of British Universities

A report of proceedings at the Conference of the Home Universities, held at the University of London during December 15–16, 1950, has now been published (pp. 119; London: Association of Universities of the British Commonwealth, 1951; 1*s*.). It includes the text of addresses by Profs. W. Fisher Cassie, T. S. Simey, Sir Lionel Whitby and R. D. Waller at the session on "The University as a Regional Focus", by C. E. Escritt and T. R. Henn at the session on "National Service and the Universities", and by Dr. G. V. Allen and Sir Ronald Adam at that on "Overseas Students in British Universities", as well as summaries of the discussions.

University of London: Appointments

Dr. Bernhard Katz, reader in experimental physiology in University College, has been appointed to the University chair of biophysics tenable in University College from January 1, 1952. The following titles have been conferred in respect of posts held at the places mentioned: professor of applied mechanics in the University on Dr. Hugh Ford (Imperial College of Science and Technology); professor of technical optics in the University on Dr. W. D. Wright (Imperial College of Science and Technology); professor of veterinary physiology in the University on Dr. E. C. Amoroso (Royal Veterinary College); professor of veterinary pathology in the University on Mr. T. J. Bosworth (Royal Veterinary College).

Leverhulme Research Fellowships, 1951

THE following awards for research, tenable for periods up to two years, and for the subjects mentioned, have been made by the trustees of the Leverhulme Fellowships: *Fellowships:* T. J. Dunbabin, fellow and reader in classical archæology, All Souls College, Oxford (Greece and the Orient in the eighth and seventh centuries, B.C.); Dr. R. F. Fortune, senior lecturer in anthropology, University of Cambridge (investigation of change in central New Guinea highlands societies since pre-conquest observations in 1935); Miss P. M. Kemp, formerly lecturer, University of Allahabad (household economy and technology of some tribal communities, Punjab); M. C. K. Tweedie, Laboratory of Human Nutrition, University of Oxford (statistical estimation problems in non-Gaussian distributions). *Research Grants:* Miss B. de Cardi, assistant secretary, Council for British Archæology (an exploratory survey of prehistoric sites on the eastern borders of Baluchistan); Mrs. S. Davis, Extra-Mural Department, University of Manchester (agriculture in Cheshire, 1750–1850, in relation to contemporary industry); R. C. Ellis, education officer and headmaster, Basutoland High School, Maseru (Basotho indigenous songs and verse); J. M. Hartog, joint reader, Oxford and Cambridge Spitsbergen Expedition, 1951 (photographic and cartographic work in connexion with the Expedition); E. M. Jope, Department of Archæology, Queen's University, Belfast (economic geography of the Oxford region in the Middle Ages); Dr. W. G. Keyworth, East Malling Research Station (hop diseases in the United States and current research on *Verticillium* wilts); Miss J. M. Lambert, Leverhulme Research Fellow (ecological investigations into the vegetation in the region of the Norfolk Broads); G. F. Mitchell, fellow and tutor in geology, Trinity College, Dublin (plant fossils from late-glacial and post-glacial deposits in the British Isles); T. B. Mitford, lecturer in humanity, University of St. Andrews (continuation of archæological research in Cyprus); Dr. J. Needham, Caius College, Cambridge (completion of a study of science, scientific thought and technology in the Far East). Further information can be obtained from the Secretary, Leverhulme Research Fellowships, 3–5 Salisbury Square, London, E.C.4.

Kalinga Prize for Scientific Popularization

AN international annual prize of £1,000 sterling for the best works of scientific popularization has been established by Mr. M. B. Patnaik, an Indian industrialist, and will be awarded under the auspices of Unesco. The prize will bear the name of Kalinga, the empire which covered part of India and Indonesia three centuries before the Christian era, and which was conquered by the Emperor Asoka, who resolved, on the occasion of his conversion to Buddhism, never again to resort to the use of armed force. In co-operation with the International Council of Scientific Unions, Unesco will draw up and publish the rules for competition for the prize; and the first award will be made in 1952. Further information can be obtained from Unesco, 19 Avenue Kleber, Paris XVI^{e}.

Announcements

PROF. A. A. HALL, Zaharoff professor of aviation in the University of London and head of the Department of Aeronautics, Imperial College of Science and Technology, has been appointed director of the Royal Aircraft Establishment, Farnborough, in succession to the late Mr. W. G. A. Perring. Prof. Hall worked at Farnborough during 1938–45, before going to the Imperial College (see *Nature*, August 19, 1944, p. 234).

THE honorary degree of D.Sc. of the University of Birmingham has been conferred on Sir James Chadwick, master of Gonville and Caius College, Cambridge, Sir Robert Davis, inventor of the Davis submarine escape apparatus, and Sir John Simonsen, director of research, Colonial Products Research Council.

DR. G. L. S. SHACKLE, reader in economic theory in the University of Leeds, has been appointed to the Brunner chair of economic science in the University of Liverpool.

THE following appointments have recently been made in the University of Sheffield: Dr. M. A. G. Kaye to be lecturer in biochemistry; Dr. W. S. Bullough to be honorary lecturer in zoology.

DR. A. M. MACBEATH has recently been appointed lecturer in mathematics in the University College of North Staffordshire. The following have been appointed assistant lecturers in the subjects shown: E. M. Yates and Dr. Monica M. Cole (geography), Dr. D. E. Davies and A. A. Shepherd (physics), T. H. White and H. Spedding (chemistry), Ruth M. Badcock (biology), F. Moseley and R. Barrass (geology).

THE Adams Prize for 1949–50 of the University of Cambridge has been awarded jointly to the following, for essays on the subjects mentioned: Dr. G. K. Batchelor ("The Theory of Homogeneous Turbulence"); Mr. W. R. Dean ("Problems in the Motion of an Incompressible Viscous Fluid"); Dr. L. Howarth ("Some Aspects of Boundary Layer Theory").

THE British Welding Research Association announces the following appointments: Dr. Nicol Gross, to be assistant director of research, while remaining in charge of the Association's research station at Abington; Dr. K. Winterton and H. E. Dixon, to be chief metallurgists, the former for ferrous metals, and the latter for non-ferrous metals; C. L. M. Cottrell and P. T. Houldcroft, to be assistant chief metallurgists for ferrous and non-ferrous metals respectively.

SIR WILLIAM TAYLOR, a member of the Nature Conservancy and formerly director-general of the Forestry Commission, has been appointed a member of the National Parks Commission to fill the vacancy created by the resignation of Mr. E. W. Wimble.

THE first two volumes of the proceedings of the polarographic congress, held in Prague during February (see *Nature*, March 24, p. 464), are now ready. Volume 1 contains forty-four communications, in English, German, French or Italian, sent as contributions to be published in honour of Prof. J. Heyrovský's sixtieth birthday (about 550 pp.), and abbreviated papers presented at the Congress in Russian, German, English or French (about 200 pp.). Volume 2 presents a full bibliography of polarography (1922–50), revised by Prof. Heyrovský and his collaborators (about 250 pp.); Russian polarographic publications are quoted in Russian characters. Inquiries about these volumes should be sent to Orbis-Export-Import, Prague I., Národní 37, Czechoslovakia.

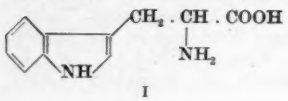
INTERMEDIARY METABOLISM OF TRYPTOPHAN

By Dr. C. E. DALGLIESH, Dr. W. E. KNOX* and Dr. A. NEUBERGER, F.R.S.
National Institute for Medical Research, Mill Hill, London, N.W.7

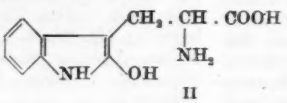
CONSIDERABLE advances have been made in recent years in our knowledge of the metabolism of tryptophan, and the experimental results suggest a general similarity of the enzymic reactions concerned in mammals, insects, fungi and bacteria. From the cumulative evidence obtained in studies with these widely different organisms, it would appear that the following represents one major pathway of tryptophan metabolism: tryptophan → formylkynurenine → kynurenine → 3-hydroxykynurenine 3-hydroxyanthranilic acid → nicotinic acid. In spite of the large volume of work in this field, much remains to be done on the elucidation of the enzyme systems involved, on the identification of postulated and as yet unknown intermediates, and on the study of alternative pathways. The work to be described was undertaken to fill some of these gaps.

First Step in the Oxidation of Tryptophan

It has generally been assumed that tryptophan (I) is first oxidized to α-hydroxytryptophan (oxindolylalanine, II) and that this compound is then transformed with uptake of one further atom of oxygen to kynurenine (III). Support for this hypothesis was



I



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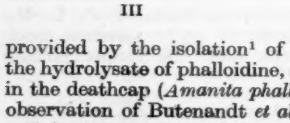

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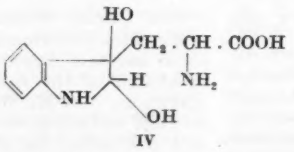

IV

provided by the isolation[1] of oxindolylalanine from the hydrolysate of phalloidine, a toxic peptide present in the deathcap (*Amanita phalloides*), and also by the observation of Butenandt *et al.*[2], that (II) had some activity as precursor of the eye-pigment in mutants of *Drosophila melanogaster*. Various attempts to prepare oxindolylalanine have been made, but it was not until recently that this amino-acid has become available. Two independent syntheses[3,4] have been reported, and it has thus become possible to test this hypothesis.

The results obtained in this laboratory indicate clearly that oxindolylalanine is certainly not a normal intermediate in tryptophan metabolism. Thus, it has been found that the patterns obtained on paper-chromatographic examination of urines from normal or pyridoxine-deficient rats after feeding oxindolylalanine are quite different from those obtained after feeding supplementary tryptophan. After feeding tryptophan no oxindolylalanine can be detected, and after feeding oxindolylalanine none of the usual intermediates of tryptophan metabolism (see below) can be detected. Moreover, the liver tryptophan peroxidase–oxidase system of Knox and Mehler[5] was found to be quite inactive towards oxindolylalanine. Japanese workers[6] have shown that oxindolylalanine is not metabolized by *Pseudomonas* which had been adapted to tryptophan and kynurenine. Recently, Mason and Berg[7], using liver and kidney slices, have also suggested that oxindolylalanine is not a tryptophan metabolite.

There is also some doubt as to whether oxindolylalanine is, in fact, a natural product. Cornforth, Dalgliesh and Neuberger[8] have pointed out that the ultra-violet absorption of phalloidine indicates strongly that the oxindole structure is not preformed in the intact molecule, and it was suggested that the oxindolylalanine obtained on hydrolysis may be a degradation product of a 2-substituted indole. The low activity of oxindolylalanine observed by Butenandt *et al.*[2] in the eye-pigment test may still be due to an enzyme oxidizing oxindolylalanine to kynurenine in the larvæ; but it appears to us more probable that the results can be explained by the observation that oxindolylalanine, after standing in solution for some days, is largely decomposed, and among the decomposition products kynurenine may be detected.

The finding that formylkynurenine may be formed enzymically from tryptophan *in vitro* suggests that the indole ring is split oxidatively between C^2 and C^3. This may proceed by a hydroxylation mechanism giving as the first product of tryptophan oxidation 2 : 3-dihydroxy-2 : 3-dihydrotryptophan (IV)[5], which could then be further oxidized to formylkynurenine. No direct evidence for (IV) has, however, yet been encountered.

Excretion of Tryptophan Metabolites by Pyridoxine-deficient Rats

The urine of pyridoxine-deficient rats fed supplementary L-tryptophan, which has previously been shown to contain xanthurenic acid[9], is particularly rich in tryptophan metabolites. The urine obtained from pyridoxine-deficient rats fed 0·1 gm. L-tryptophan per day for one or two days was treated, after acidification and removal of insoluble material, with mercuric acetate. The precipitate was decomposed with hydrogen sulphide and the solution chromatographed on paper using (mainly) butanol-acetic acid. Under ultra-violet illumination at least nine strongly fluorescent spots appear (Fig. 1; under the conditions used tryptophan itself does not fluoresce). Strips of the chromatograms were also treated with ninhydrin, and with the reagents of Ehrlich, Hellmann[10] and Pauly. In addition, the spots were extracted into buffer (*M*/5 phosphate, *p*H 7·0, diluted 1 : 10) and the solutions examined spectroscopically. Samples of the urine were also hydrolysed with 5*N* hydrochloric acid in a sealed tube at 100° for one hour, and the hydrolysates re-examined.

Not all the spots have as yet been identified; but various conclusions can be drawn. None of the spots is given by the urines of normal rats fed similar amounts of tryptophan, or by the urines of pyrid-

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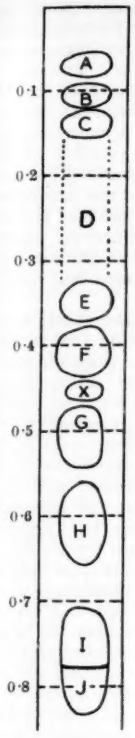

Fig. 1. Approximate R_F values of fluorescent spots obtained from urine of tryptophan-fed pyridoxine-deficient rats on paper chromatography in butanol-acetic acid

oxine-deficient rats not receiving tryptophan supplement. The conclusion is thus justified that these spots represent products of tryptophan metabolism accumulated or excreted as a result of pyridoxine deficiency.

Spot *F* is due to kynurenine, and spot *E* to 3-hydroxykynurenine. The presence of hydroxykynurenine is worthy of note. It has been found in *Calliphora*[11] and *Bombyx mori*[12]; but so far as we are aware has not previously been reported in the excretion of mammals. Its recognition in the urine of pyridoxine-deficient rats supports the concept that 3-hydroxykynurenine is an intermediate in the tryptophan metabolism of vertebrates. Spot *H* is due to a mixture of kynurenic and xanthurenic acids.

Spots *A*, *C*, *I* and *J* gave ultra-violet spectra identical in type with those of kynurenine and hydroxykynurenine. The spectrum of spot *X* resembles that of spot *H* closely, while the spectrum of *B* is somewhat similar. The assumption that *A*, *B*, *C*, *X*, *I* and *J* represent derivatives of the two kynurenines and of the two quinoline-carboxylic acids is supported by the fact that after hydrolysis only the spots due to kynurenine, hydroxykynurenine and kynurenic plus xanthurenic acids remained, these being more intense than before hydrolysis. It was therefore concluded that the urine contained, in addition to kynurenine, hydroxykynurenine, kynurenic and xanthurenic acids, comparable quantities of conjugation products of these substances. *D* is a region of weak general fluorescent and ninhydrin-positive background without outstanding spots, and *G* has as yet been little investigated but is probably also a conjugated metabolite.

The identity of spot *J* was definitely established, and the identity of spot *I* can be postulated with high probability. Spot *J* agreed in chromatographic and chemical behaviour in all respects with synthetic N^{α}-acetyl-DL-kynurenine, and the identification was strongly supported by the following experiment: A pyridoxine-deficient rat was fed at the same time 0·2 gm. L-tryptophan and 3·0 mgm. sodium acetate labelled in the methyl group with carbon-14 (36·6 μC.). A chromatogram was obtained in the usual way and the relative radioactivities of the spots were determined by a mechanical scanning technique[13]. Fig. 2 shows that the greatest radioactivity corresponds to spots *I* and *J*. It is suggested that spot *I* corresponds to N^{α}-acetyl-3-hydroxykynurenine. This is based on a comparison of the R_F values, colour reactions, and absorption spectra of spots *F* and *J* (kynurenine and its acetyl derivative) and spots *E* (hydroxykynurenine) and *I* (its postulated acetyl derivative) and is supported by the result of the above experiment (Fig. 2).

N^{α}-Acetylkynurenine has been previously isolated from a mutant strain of Neurospora[14]. The presence in urine of acetyl derivatives of normal metabolites is of some interest; but the significance of the finding cannot as yet be readily assessed.

The identity of the remaining unknown spots is at present being investigated. The following could not be detected on the chromatograms: oxindolylalanine, N^{α}-acetyltryptophan, anthranilic acid, 3-hydroxyanthranilic acid, acetylanthranilic acid, indole, skatole, indole acetic acid, indole propionic acid, indole pyruvic acid, tryptamine, *o*-aminoacetophenone, nicotinic acid, nicotinamide, nicotinamide methochloride, or quinolinic acid. Treatment of the urine preparations with formylase[5] showed no increase in kynurenine, and therefore the absence of formylkynurenine; this is to be expected owing to the ready hydrolysis of the formyl group.

Kynureninase and Pyridoxine in Tryptophan Metabolism

An enzyme in liver, kynureninase, was described by Kotake and Nakayama[15] and further studied by Wiss[16], who showed that the reaction was specific for L-kynurenine, and formed anthranilic acid and alanine. The work of Braunshtein *et al.*[17] demonstrated that the kynureninase activity was decreased in pyridoxine deficiency, and that the enzyme required pyridoxal phosphate. The possibility that the interruption of this reaction in pyridoxine-deficiency produced the abnormal accumulation of tryptophan metabolites prompted us to investigate it further.

The activity of kynureninase in liver is low, comparable to that of the tryptophan peroxidase[5], and only about 10 μmol. of kynurenine react per gm. liver (dry wt.) per hr. The long (20 hr.) reaction periods mostly used by previous investigators can be replaced

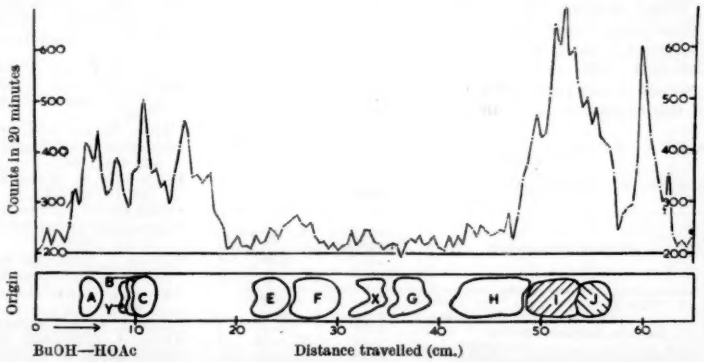

Fig. 2. Comparison of radioactivity and location of fluorescent spots on a chromatogram obtained after simultaneous feeding of tryptophan and ^{14}C-labelled acetate to a pyridoxine-deficient rat. Spot *F* is a 'pigment' spot, not derived from tryptophan

Table 1. Effect of Pyridoxine on Kynureninase Activity *in vivo* and *in vitro*

0·5 ml. of rat liver enzyme preparation plus 1·0 μmol. L-kynurenine and 0·1 ml. 0·2 *M*-borate, *p*H 8·0, in a total volume of 1·2 ml. Pyridoxal phosphate added as indicated. Deproteinized with 4 ml. of ethanol after 40 min., incubation at 38°. Initial and final determinations of kynurenine in the reaction mixtures were calculated from the absorptions at 365 mμ minus the absorptions of controls containing no kynurenine

Enzyme preparation	Pyridoxal phosphate added μgm.	Kynurenine μmol./gm. dry wt.	Disappearance μmol./ml.
Homogenates, normal rats	0	9·6 (12 animals)	
,, pyridoxine-deficient rats	0	2·7 (2 animals)	
Supernatant, dialysed (normal rats)	0		0·37
Supernatant, dialysed (normal rats)	10		0·49
Ethanol precipitated	0		0·46
,, ,,	10		0·60
Precipitated with ethanol and ammon. sulphate	0		0·18
Precipitated with ethanol and ammon. sulphate	10		0·44

by short-term experiments using more sensitive methods. We have measured the disappearance of kynurenine by the decrease in absorption at 365 mμ. Under our conditions (Table 1), the amount of kynurenine disappearing is proportional to time and to the amount of enzyme present. From the increased absorption at 310 and 330 mμ, in the same solution, can be calculated the amount of anthranilic acid and the small amount of kynurenic acid formed by the reaction. The products, alanine, anthranilic acid and kynurenic acid, have been identified by paper chromatography. Approximately twenty-fold purification of the enzyme in a liver homogenate has been obtained by the removal of insoluble material at *p*H 5, followed by ethanol and by ammonium sulphate fractionations. The enzyme from normal rats has been partially resolved by treatment with ammonium sulphate and shown to require pyridoxal phosphate as coenzyme (Table 1). The kynureninase activity was markedly decreased in pyridoxine-deficient rats. These findings confirm those of Braunshtein *et al.*

The purified kynureninase preparation also splits hydroxykynurenine to analogous products and at roughly the same rate as L-kynurenine (compare ref. 18). Acetylkynurenine, however, is acted upon only after it is hydrolysed to kynurenine by a deacetylase present in liver and still not completely separated from our best preparations of kynureninase.

These actions of kynureninase, dependent upon pyridoxine, could account for the accumulation of kynurenine and hydroxykynurenine in pyridoxine-deficient rats given tryptophan. Of additional interest is the persistent formation of small amounts of the quinoline carboxylic acids, apparently by the same reaction. Approximately the same proportion of total degraded kynurenine goes to form kynurenic acid by the action of either crude or purified enzyme. Furthermore, it was found that the amount of kynurenic acid formed could be increased by the addition of excess pyruvate to the reaction, without a comparable increase in the total kynurenine disappearing. The degree of increase possible in this way was similar in both crude and purified enzymes (Table 2). The lack of summation and the parallelism with crude and purified enzymes in yields of the two aromatic products derived from kynurenine suggest that kynurenic acid is a by-product of the same set of reactions which form anthranilic acid and alanine from kynurenine.

Table 2. Kynurenic Acid Formation as a By-product in the Kynureninase Reaction

Experimental conditions as in Table 1, with the addition of 10 μmol. of lithium pyruvate as indicated

Enzyme preparation	Kynurenine disappearance μmol.	Kynurenic acid formed μmol.
1. Crude liver supernate	0·49	0·06
,, ,, +pyruvate	0·53	0·13
2. Ammon. sulphate fraction	0·57	0·01
,, ,, +pyruvate	0·62	0·16
3. Ethanol and ammon. sulphate fraction	0·90	0·33
,, ,, ,, +pyruvate	0·88	0·67

The mechanism of the kynureninase reaction has not yet been elucidated. The possibility that alanine is formed from kynurenine by two transamination reactions, in the way that alanine arises during tyrosine metabolism[19], is excluded by the finding that neither the addition of α-ketoglutarate nor of pyruvate is necessary for the reaction, even in the most purified preparations. These experiments did, however, reveal the effect of pyruvate, and to a lesser extent that of α-ketoglutarate, in increasing the proportion of kynurenine going to kynurenic acid. If kynurenic acid is formed as a by-product of the main kynurenine reaction this would be indirect evidence for an intermediate deamination of kynurenine to an α-keto acid, as opposed to the direct fission of kynurenine. The mechanism would involve the formation of the α-keto acid corresponding to kynurenine and its hydrolysis to anthranilic acid and pyruvate. The deamination of kynurenine to its keto acid, and the reamination of the pyruvyl fragment to form alanine, could occur through a cyclic transamination of the coenzyme for the reaction, pyridoxal phosphate. Excess pyruvate would then hasten the regeneration of pyridoxal phosphate, and increase the deamination of kynurenine. Some of the unstable keto acid accumulating under these conditions would form kynurenic acid by ring closure before it could be hydrolysed.

We are greatly indebted to Prof. A. Butenandt for a specimen of synthetic hydroxykynurenine and for making available to us prior to publication the paper by Dr. H. Hellmann, and to Dr. W. W. Umbreit for a gift of pyridoxal phosphate.

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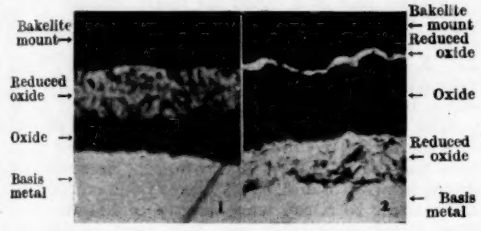
REDUCTION OF FERROUS OXIDE

By O. H. GELLNER and Dr. F. D. RICHARDSON
Nuffield Research Group in Extraction Metallurgy, Royal School of Mines, South Kensington, S.W.7

SINCE most of the previous research on the reduction of iron oxides has been carried out on ores and other poorly controlled and impure materials, we started some time ago on a systematic investigation of the reduction of the oxides of iron. So far the investigation has only properly covered the reduction of polycrystalline layers of wüstite—the non-stoichiometric ferrous oxide approximating to the composition $Fe_{0.95}O$ when in equilibrium with iron. These were prepared on polycrystalline strips of Swedish iron. The impurities in this metal totalled 0·3 per cent, of which 0·15 per cent was manganese and 0·04 per cent tungsten. Although not complete, the results so far obtained are of considerable interest. The work is being continued and it is intended to publish a full report elsewhere at a later date.

Layers of wüstite approximately 10^{-2} mm. thick were prepared by passing controlled mixtures of hydrogen and water vapour over strips of the iron at 900° and 950° C. The layers were then reduced in hydrogen at temperatures ranging from 600° to 1,000° C. The kinetics of the reduction were studied by collecting and weighing the water produced, and the mechanisms followed by microscopic examination. Reduction of the specimens could be arrested at any desired stage by drawing them into a cool part of the furnace, where they were rapidly quenched to room temperature.



Wüstite layer on iron partially reduced at (1) 700° C. (× 850) (2) 950° C. (× 650)

Photomicrographs of cross-sections of two typical specimens after partial reduction are shown. At 700° C. (Fig. 1) reduction of the wüstite layer proceeds, as would be expected, from the surface inwards, a spongy layer of iron being produced. At 900° C. and above (Fig. 2) a very thin film of iron first forms on the oxide surface; but its growth soon ceases. Virtually all the reduction then proceeds outwards from the interface where the basis metal meets the oxide layer. At intermediate temperatures reduction proceeds simultaneously inwards from the surface and outwards from the metal. The results with different specimens at each temperature were consistent and reproducible.

One would have expected that reduction at all temperatures would have proceeded from the surface inwards. The fact that it proceeds outwards at the higher temperatures indicates that layers of wüstite grown under our conditions have some unexpected properties.

It appears to us that the most simple explanation consistent with all the facts is that the oxide in the immediate neighbourhood of the basis metal is less stable than the oxide on the surface and that there is a gradation of stability across the layer. This might be due, for example, to strain, which has commonly been shown to occur in oxide films[1], and which might be expected to decrease gradually with distance from the metal. On this hypothesis the course of reduction would be as follows: (1) removal of oxygen by hydrogen from the surface of the oxide with resultant supersaturation of the oxide with iron; (2) nucleation of this excess iron to form a thin layer of massive metal on the surface; (3) retardation of further reduction by the surface metal, which restricts access of hydrogen to the oxide and the diffusion of water vapour away from it; (4) diffusion of the excess iron, produced in the outermost layers of oxide by the continuing reduction, into the body of the oxide; (5) when the temperature is high enough and the diffusion rapid enough, preferential growth of massive iron outwards from the basis metal, where the oxide is least stable.

Steps (1)–(3) inclusive are clearly operative at all temperatures and their mechanisms do not need further discussion here. Step (4) might take place both by movement of excess iron atoms towards the basis metal via the vacant iron lattice sites normally present in wüstite (about 5 per cent in equilibrium with massive iron) and by movement of oxygen atoms towards the surface to fill the vacant oxygen sites produced at the surface by the reduction.

Either diffusion process would be expected to have a high activation energy and hence a high temperature coefficient. For an activation energy of 50 k.cal., for example, the diffusion coefficient could increase 85-fold between 700° and 900° C. Diffusion could therefore bring about concentration gradients of excess iron across the oxide layer which change markedly with temperature, and might reasonably have the forms represented diagrammatically in Fig. 3. The more stable oxide should require a greater supersaturation with excess iron than the less stable, before massive iron can grow continuously from it. If these supersaturation limits (c_1 and c_2) are as illustrated in Fig. 3 relative to the concentration gradients of the excess iron, the results obtained in practice would automatically follow.

In conformity with this theory we found that the course of reduction was independent of whether the oxide layers were prepared and reduced above or below the α–γ transformation temperature in iron (910° C.), or whether the substrate metal was oxidized completely away. In addition, we have found that if a completely oxidized specimen is annealed for a sufficiently long period to produce recrystallization,

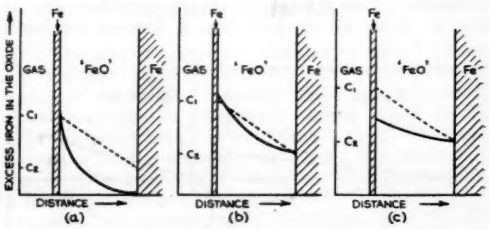


Fig. 3. Schematic representation of concentration gradients (full lines) of excess iron across the oxide layer at (*a*) 700° C., (*b*) 800° C. and (*c*) 900° C. c_1 and c_2 represent the super-saturation limits required for growth of massive iron at the oxide surface and the oxide–basis metal interface respectively. The broken lines suggest how these limits may vary across the layer

the grains of oxide are then reduced more or less uniformly over their entire surfaces and there is no difference in behaviour between the material near the surface and that near the centre of the strip.

Since the first layers of wüstite formed initially on iron appear to be less stable than the massive oxide, their formation must require a higher oxygen potential than equilibrium between bulk phases of metal and oxide would indicate. The phenomenon represents a new type of passivity which may well vitiate equilibrium measurements involving formation of very small quantities of a new phase on a bulk substrate. It may account for the discrepancies reported in studies of the equilibria between solid iron and liquid and solid wüstite, in carbon monoxide–dioxide and hydrogen–steam gas mixtures[2–4]. These equilibria have been studied under conditions where solid iron is just oxidized, so that in cases where the oxide formed is solid the oxygen pressure will be higher than that for the bulk phase. When the product is liquid, no such passivity should occur, so that the equilibrium oxygen pressure will be lower than the solid results would indicate, when allowance is made for the change in state. This effect may also account for the unexpected passivity reported by Chipman and Marshall[2] when treating solid iron specimens under conditions which were just oxidizing.

The work reported here was done in the Chemistry Laboratories of the British Iron and Steel Research Association while we were members of the staff of that Association. [Jan. 9.

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X-RAY SHADOW MICROSCOPE

By Dr. V. E. COSSLETT and W. C. NIXON
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THE advantages of the short wave-length of X-rays may be exploited for microscopy by projecting shadowgraphs from a point source[1], the resolving power being then limited primarily by the size of the source. Electron lenses can be used for focusing the exciting beam so as to produce a point source of X-rays of very small dimensions[2]. The specimen may be kept in atmospheric conditions, and yet brought close enough to the source to give a high working magnification, if the target is in the form of a Lenard window and the transmitted X-rays are utilized[3]. The system is shown schematically in Fig. 1, where an electron lens L focuses the beam

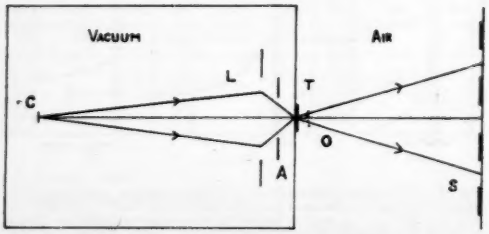

Fig. 1. Principle of X-ray shadow microscope

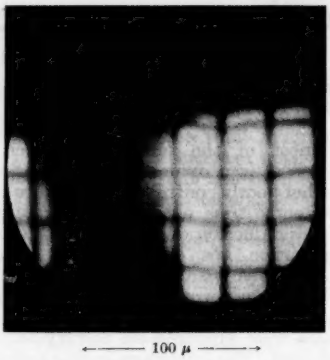

Fig. 2. X-ray shadowgraph of silver grid (1,000 mesh/in.) overlapping copper grid (200 mesh/in.). Original magnification, ×95; final magnification, ×285

issuing from a cathode C on to the target T. An enlarged shadow of an object O is thrown on to a fluorescent screen or photographic plate S. Such an arrangement is capable of much higher magnification and resolution than the procedure adopted by Goby, Dauvillier, Engström and others[4], in which the specimen is almost in contact with the recording plate and is illuminated by a distant source of X-rays of normal size. In that case the limiting factor is the grain of the photographic emulsion, and a resolution of better than 10 microns is difficult to obtain. On the other hand, the point source is in principle limited in size only by the aberrations of the electron lens and could be made smaller than 100 A.; the exposure-time would then become in practice the limiting factor.

An X-ray shadow microscope has now been developed, using a magnetic lens to demagnify the electron beam. The size of the spot obtained is of the order of 1 micron, when an aperture A is placed before the target to limit the electron beam and thus reduce the effect of lens aberrations. Accelerating voltages between 3 and 12 kV. have been employed, corresponding to X-ray wave-lengths of 1–4 A. The camera length is variable from 2 to 5 cm. or longer. Test results are shown in Figs. 2 and 3, taken at 10 kV. Fig. 2 shows a silver grid of 1,000 meshes to the inch carried on a 200-mesh/inch copper grid, the wires of the former being 5 microns in width; exposure time was 20 sec., primary magnification ×95. Fig. 3 shows a book louse (*Liposcelis granicola*) and part of a 1,500-mesh grid; exposure time 5 min., primary magnification ×25. As the 1,500-mesh grid is made of wires of 3 microns in diameter, the resolving power can be estimated to be of the order of 1 micron. The fine structures in the leg running across the bottom of Fig. 3 appear to be still thinner.

It appears that the resolution obtainable with a single stage of demagnification of the electron spot cannot, with existing electron lenses, much exceed 1 micron. The employment of two stages of demagnification raises no practical difficulty, but would seem to lack suitable biological specimens, owing to their low absorption of X-rays; it might be of more value for metallurgical investigations. In order to increase absorption, a lower accelerating voltage and correspondingly longer X-ray wave-length could be employed; but a vacuum camera would then be

Fig. 3. X-ray shadowgraph of book louse (*Liposcelis granicola*) and silver grid of 1,500 mesh/in. Original magnification, ×25: final magnification, ×37

needed and the advantage of the specimen being in air would be lost.

The apparatus described, a fuller account of which will appear elsewhere, can also be used as a fine-focus tube for X-ray analysis. Indeed, the use of a magnetic lens is similar to that in the diffraction tubes devised by Goldsztaub[5] and by Witty and Wood[6]. It gives a much smaller spot than the fine-focus diffraction tube of Ehrenberg and Spear[7], which makes the maximum use of the electrostatic focusing action of the electron gun but employs no subsequent lens.

Thanks are due to D. A. Taylor and S. S. D. Jones, who assisted in the preliminary experiments. One of us (V. E. C.) has been supported by a Keddey Fletcher-Warr Research Studentship of the University of London (at the Electrical Laboratory, Oxford, 1939–41) and by an I.C.I. Research Fellowship (at Cambridge, 1946–49), and the other (W. C. N.) by a Scholarship of the Research Council of Ontario.

[May 3.

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EMPIRE COTTON GROWING CORPORATION, 1921–50

A SHORT history of the Empire Cotton Growing Corporation, 1921–50, originally published in the *Empire Cotton Growing Review* of January 1951, is now available as a pamphlet. It includes a number of matters of scientific interest. The Corporation was incorporated by Royal Charter on November 1, 1921, as a result of the report of the Board of Trade's Empire Cotton Growing Committee in 1920, and was financed partly by a capital grant from the Imperial Government and partly by a levy on all raw cotton spun into yarn in the United Kingdom. Since the repeal of the Cotton Industry Act on March 31, 1948, the Corporation has received an annual grant of £18,000 from the Cotton Board.

Resembling in many ways a research association, the Corporation has concentrated mainly upon production, with its relevant agricultural and scientific problems and requirements. A first step was the training and enlistment of a scientific staff, and in this, since 1922, the Corporation has been in close association with the Imperial College of Tropical Agriculture in Trinidad. Relations established with the Shirley Institute at Manchester, by enabling plant-breeders to test new cottons at a much earlier stage, have led to a great saving of time, land and labour. Another early step was to enlist the help of scientific experts in general agriculture, soil science, genetics and plant breeding, plant physiology, entomology and plant pathology, and particular tribute is paid to the services of the late Sir John Farmer.

The agricultural and scientific policy of the Corporation has fully recognized that cotton-growing, to be permanent, must be associated with other crops in the general system of agriculture of the countries concerned. A Research Station was established in Trinidad in 1926 and closed at the end of 1944, when it was decided that the next phase of the work could more advantageously be carried out in a country producing a commercial cotton crop. A site for the new Station was found at Namulonge, Uganda, and of the estimated capital cost of £206,500 half was provided from Colonial Development and Welfare Funds, £78,250 from the Corporation's invested resources, and £25,000 from the Cotton Industry War Memorial Trust. The Corporation is to find £170,000 of the recurrent expenditure, estimated at £400,000 over the ten years from October 1, 1947, Colonial Development and Welfare Funds are providing £100,000 and the Governments of Uganda, Tanganyika, Nigeria, Kenya and Nyasaland, jointly, have promised £130,000. The Uganda climate has necessitated stationing the Cytogenetics Section at Shambat, near Khartoum. Figures are quoted to demonstrate, on the basis of record crops, the capacity of the Empire to grow more than a million bales of cotton per annum; and three-year averages show that production in the Anglo-Egyptian Sudan has increased from 23,225 bales in 1918–21 to 299,872 in 1946–49; in Uganda from 55,196 to 262,929; in Kenya from 233 to 6,574 bales; and in Tanganyika from 2,442 to 48,345 bales, for the same periods.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS

AT the invitation of the Camberley and District Natural History Society, the South-Eastern Union of Scientific Societies held its fifty-sixth annual congress at Camberley during April 26–29 under the presidency of David Seth-Smith. The local committee for the congress was under the chairmanship of Major Maxwell Knight, with Miss Jean Armitage as local secretary.

At the 'young naturalists' evening', Dr. W. E. Swinton, of the British Museum (Natural History), lectured on "Prehistoric Reptiles", illustrating his remarks with lantern slides and films. A Nature quiz competition took place between teams from the junior section of the Natural History Society and the

local schools. The junior section also largely contributed to the success of an excellent nature-study exhibition by displaying specimens, examples of their field-work, notebooks and drawings.

The presidential address to the Zoological Section was given by Sir Philip Manson-Bahr, who spoke on "The Contribution of Zoology to Medicine". He dealt with the early investigations into the causes of elephantiasis and malaria and with subsequent work upon the life-cycles of the insects responsible for these and other diseases. A. J. Low gave the presidential address to the Geological Section and conducted an excursion to the Jealott's Hill Research Station of Imperial Chemical Industries, Ltd., where he demonstrated some of the points of his address dealing with soil fertility, the influence of leys, microlysimeters and soil profiles,

Mr. Seth-Smith's presidential address to the Union was on "Man's Control of Wild Animals". He commenced by saying that there are people who think that zoological gardens should not be allowed to exist, as it is cruel to confine any wild animal. Such people invariably say they do not visit the zoo because they do not approve of it. Mr. Seth-Smith said that he has always been fond of animals and so of zoos, for there one can see animals which one could never hope to see in a wild state, can study their forms and actions, and know them individually and intimately. All domesticated animals were derived from wild species, and the world is now dependent upon them for its very existence. The camel was domesticated so long ago that it is not known where its wild home was. Job possessed six thousand of them, so that they were domesticated before his time. In England the first real zoological gardens was established by Henry I at Woodstock in Oxfordshire; it was removed to the Tower of London by Henry III and was transferred to Regent's Park, London, on the formation of the Zoological Society in 1829. Zoos are of the greatest educational value, for though the student can read about animals and see their stuffed skins in museums, it is not until he observes them in the wild or in captivity that he acquires a true idea of their living form.

Dealing with the problem of how do animals feel about being in a zoo, Mr. Seth-Smith said his thirty years of experience as curator led him to think that the majority, if capable of choosing, would vote for a safe and comfortable home in captivity. Most animals in a zoo are born there or are brought in from the wilds when quite small babies. Most wild animals have their own areas in which they live, and in captivity they regard their enclosures as their territories and apparently are not particular as to their size. Scientific experts are employed to ensure the health and happiness of the animals. As an example, almost every wild animal suffers from internal parasites. The very first thing at a zoo with a new arrival is thorough examination for, and treatment of, these pests. Very few wild animals die of old age or sickness. The majority are preyed upon, while the predators when old or infirm either die of starvation or are themselves killed. In zoos they live their full lives, the span of which is longer than their chances in a native haunt. Man is the greatest enemy of all wild life; his greed, cruelty and ignorance are leading to its extermination even to-day. Wild animals are afraid of man when taken under his control; but when well treated, well fed and safe from enemies, they soon become reconciled and regard man as their protector. Some animals have been saved from total extinction by being taken into zoos and collections. Were it not for zoological gardens we should have a poor idea of the wonderful animals that share the earth with us and should have to rely chiefly upon the stories of hunters, whose chief idea was perhaps to magnify the danger in their destruction.

Other events that took place at the meeting are, briefly, as follows. Prof. F. W. Jane, as president of the Botanical Section, spoke on "Trees and Scenery", and H. H. Coghlan chose for his presidential address to the Archæological Section the theme "Aspects of Prehistoric Metallurgy in Southern England". Excursions were conducted to Frensham Pond and Haslemere Museum with Major Maxwell Knight and Francis Rose as leaders. C. D. Ovey described aspects of weather and weather forecasting, showing 'Kodachrome' slides of features of meteorological interest. He stressed the importance of relating scientific observations with those of the field naturalist and the farmer. At the general assembly the methods of developing the usefulness of the Union to its affiliated societies was discussed at length and a sub-committee appointed to formulate schemes for that purpose.

SOUTH-WESTERN NATURALISTS' UNION

ANNUAL CONFERENCE

THE South-Western Naturalists' Union held its 1951 annual Whitsuntide conference (the twenty-fourth) during May 11–14 at Taunton as guests of the Somerset Archæological and Natural History Society. It was to this Society, and particularly to the hard work of the local secretary, A. D. Hallam, in planning the programme, that the success of the conference was largely due.

A reception was held by the Mayor, Councillor W. F. Heywood, at the Municipal Buildings on the evening of May 11, and then on the following day nearly sixty members visited the Blackdown Hills under the leadership of Mr. and Mrs. Hallam. Halts were made at Priors Park Wood, Britty Common, Castle Neroche and Ashill Church. At Priors Park Wood, where many birds, including the nightingale, were heard and where several badger setts were seen, the attention of the botanists was directed to the marked influence that changes in the geological formation had upon the vegetation. On Britty Common exposures of the Upper Greensand and overlying gravels were examined by the party. H. St. George Gray conducted the party over the earthworks of Norman date known as Castle Neroche, and the interesting features of Ashill Church were explained by Mr. Hallam. In the evening, W. A. Seaby lectured on Ham Hill, where many important finds of late Iron Age and Roman date have been made; the talk was amply illustrated by lantern slides.

Most of May 13 was taken up by an excursion to the region around Minehead. In the morning, Porlock Marsh was explored, under the guidance of H. G. Hadden, for plants and animal life; and members visited the village of Bossington, after which they drove to Horner Woods and from there to Minehead. After tea the party divided; one half visited Cleeve

Abbey, which was described by Mr. Seaby, and the other half, the cliffs at Watchet, where the Keuper and Lower Lias are well exposed. The geology was explained by Mr. Hallam and Dr. Stanley Smith. In the evening Peter Scott, president of the Union, delivered his address; he explained two coloured films, one of bird life in northern Europe taken during his visit to Scandinavia in 1950, and the other illustrating experiments in netting wild geese for the purpose of ringing. In this work, nets are carried over the flock after it has settled, by means of rockets electrically exploded.

The final morning was occupied by the council and general meetings, with A. O. Rowden presiding over both. In the course of his remarks at the general meeting, Mr. Rowden alluded to the recent public inquiry into the use by the military of Braunton Burrows and to the matter of footpaths. The secretary reported that the South Western Naturalists' Union embraces at the present time twenty-one affiliated societies or sections of societies.

SILTING IN BRITISH RESERVOIRS

By R. M. PROTHERO

ARTICLES in previous issues of *Nature*[1] have stressed the need for the proper study of the relationship between rainfall and run-off in Britain, since its influence in promoting soil erosion, dependent on the vegetation cover and on the soil cover itself, may be more considerable than we imagine. There is the danger that because of the lack of spectacular examples of soil erosion such as occur in other parts of the world, we may ignore it and fail to realize its presence. As a result of this attitude, precise information is practically non-existent and it is necessary to rely on evidence which is fragmentary in nature and which has often been collected only incidentally.

Important evidence relating to the removal of soil by heavy rainfall is provided by information on the silting, caused by the deposition of this material, of British reservoirs. A survey, covering twenty-eight of the major water-undertakings in Britain, revealed in the first place an absence of any co-ordinated information. An attempt to survey the floor of a reservoir in the Tâf Fawr valley, Breconshire, during the drought of 1949 was unfortunately unsuccessful owing to the onset of rain. This would undoubtedly have provided important and precise evidence as to the rate of silting in that area.

It is possible to prevent the transport of material of large size into reservoirs by the construction of catch-pits and wreck-lodges in the tributary streams. To prevent the entry of finer material, carried in suspension during periods of high stream flow, is a more difficult problem. Such material, deposited on the floor of a reservoir, may accumulate in a short time and seriously reduce its capacity. In Great Britain examples are not so outstanding as in the United States, where in 1934 the Soil Conservation Service reported that in a survey of fifty-six reservoirs, it was found that thirteen major dams, with an average height of 30 ft., had silted up completely during an average life of twenty-nine years.

The most outstanding example in Britain known to me, of nearly a 50 per cent reduction in capacity in seventy-eight years, has already been quoted in a previous article[2]. Rates of silting vary considerably: from an accumulation during a hundred years of 6 ft. of silt on the floor of a reservoir with an area of 40 acres and an average depth of 25 ft. at the time of construction; to 6 in. accumulated over a 44-year period. In many of the reservoirs there is no marked silting at all, but in eleven out of the twenty-eight undertakings for which information was received it will become serious within the next hundred years. But even if the rate of silting is slow, we must take a long-term view of our facilities for providing water, remembering that demands on available supplies are steadily increasing. In four reservoirs built in 1798, 1830, 1876 and 1880, capacity has been reduced by 12, 12, 5·5 and 8 per cent respectively; but the situation will become serious only if an increased demand exceeds the surplus available at the present time. In such circumstances the engineer reported that it would be more practical to increase capacity by raising the top-water-level of the reservoirs rather than to attempt to remove the silt. In only one instance was there an actual reference to allowance being made for reduction in capacity by silting at the time of the construction of the undertaking. The allowance was for a 20-million gallon reduction in the case of one reservoir and of 10 million gallons each for the other two. But though allowance had been made for reduction in total capacity, several hundred tons of silt had to be removed from around the draw-off tunnel of one of the reservoirs in 1933.

The problem of silting does not appear to have been allowed for in the calculated capacities of the reservoirs now being constructed as an integral part of the hydro-electric power schemes in the Scottish Highlands. In fact, the possibility of the problem arising does not seem to have been considered. A recent article on the developments taking place[3] stated that, in addition to the influence they would exert on flood control, "The reservoirs will also act as traps for sand and silt which at the present time are washed down to the sea and in many places, particularly on the north-east coast, have filled up estuaries and harbours".

While acknowledging the benefit to Scottish harbours, it must be pointed out that this will only be attained at the expense of creating a problem in the reservoirs themselves. The dredging of a harbour would appear to be a much simpler operation than the removal of silt from a reservoir, quite apart from the interference with water supply to the turbines entailed in carrying it out.

Silting is most marked where erosion, particularly by gullying in the beds of the streams feeding the reservoirs, takes place in deposits of sand and peat. It is also a feature where glacial till, widespread in the north and west of Britain, is being eroded. In being complementary to erosion, silting is the most significant evidence available of the existence of the former. Even if silting may not become a serious problem for a hundred years or more, the time to take action to prevent it is at the present. The remedial measures necessary have been stated in previous articles; but in order that they may be planned to produce the maximum effect it is essential that a considerable body of accurate information be accumulated on the related factors of rainfall, run-off, erosion and silting.

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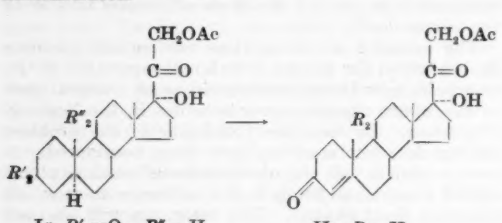
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Cortical Hormones from *allo*Steroids: Synthesis of Cortisone from Reichstein's Compound *D*

CORTISONE acetate (II*b*) has so far only been synthesized[1] from bile acids which possess the 'normal' configuration at C-5 (rings *A*/*B cis*). Since the potentially most abundant sources, such as the steroidal sapogenins, belong to the *allo* series (rings *A*/*B trans*) or are readily convertible to the latter, it is important to accomplish the transformation of an *allo*steroid to cortisone. We have recently described[2] a method for the conversion of 3-keto-*allo*steroids into Δ^4-3-ketones, which involved dibromination to a 2,4-dibromo derivative, treatment of the latter with sodium iodide in acetone solution to yield a 2-iodo-Δ^4-3-ketone and subsequent de-iodination with chromous chloride, collidine or zinc. This procedure was applied successfully in the androstane, etio*allo*cholanic acid and *allo*pregnane series. The usefulness of this method for the important 17,21-dihydroxy-20-keto steroids remained to be demonstrated.



Ia, R'_2=O; R''_2=H_2

b, R'_2=H, OH; R''_2=O

c, R'_2=R''_2=O

IIa, R_2=H_2

b, R_2=O

Fleisher and Kendall[3] have recently shown that adrenal corticosteroids possessing the 20-keto-21-acetoxy grouping are readily brominated in position 21. Since such a reaction may seriously complicate the synthesis of 2,4-dibromo derivatives of 3-keto-*allo*steroids possessing the 17,21-dihydroxy-20-keto side-chain, we have examined the sodium iodide method[2] in the case of *allo*pregnane-3,20-dione-17α,21-diol 21-acetate (I*a*)[4]. The ketone I*a* was treated at 16° in chloroform – acetic acid solution with two moles of bromine, a small amount of anhydrous hydrogen bromide in acetic acid was added to facilitate the rearrangement of the presumable[5] initial 2,2-dibromo compound to the 2,4-isomer, and after twenty hours the chloroform solution was washed free of acid and evaporated to dryness *in vacuo*. The crude 2,4-dibromo derivative was not crystallized, but was refluxed immediately with an excess of sodium iodide in acetone solution for twenty hours. After concentrating, extracting with ether, washing with thiosulphate solution and evaporating to dryness, the residue was refluxed for half an hour in dioxane solution with 5 per cent sodium bisulphite solution. This latter de-iodination procedure proved particularly suitable for adrenal hormones of type II.

Dilution with water, filtration and recrystallization from acetone afforded Δ^4-pregnene-3,20-dione-17α,21-diol 21-acetate (II*a*) (Reichstein's compound *S* acetate) of melting point 233–235° (all melting points are uncorrected), $[\alpha]_D^{20}$ + 109° (acetone), ultra-violet absorption maximum (95 per cent ethanol) at 240 mμ (log ε, 4·36). This represents the third synthesis of Reichstein's compound *S* from readily available pregnane derivatives[6].

The synthesis of *allo*pregnane-3β,17α,21-triol-11,20-dione 21-acetate (I*b*) (Reichstein's compound *D* monoacetate) was recently accomplished in this laboratory[7] from *allo*pregnane-11,20-dione-3β-ol, which in turn was obtained from a number of steroidal sapogenins. I*b* had a melting point of 235–237°, $[\alpha]_D^{20}$ + 66° (acetone) (calc. for $C_{23}H_{34}O_6$: C, 67·95; H, 8·43; found: C, 68·22; H, 8·73), and was correlated with Reichstein's compound *D*[8] via the 3,21-diacetate (m.p. 220°)[9]. Oxidation of I*b* with N-bromoacetamide in pyridine solution afforded *allo*pregnane-3,11,20-trione-17α,21-diol 21-acetate (Ic), of melting point 235–237°, $[\alpha]_D^{20}$ + 78° (acetone), + 89° (chloroform) (calc. for $C_{23}H_{32}O_6$: C, 68·29; H, 7·98; found: C, 68·13; H, 7·63). Dibromination in acetic acid solution (without chloroform), as described above for I*a*, followed by dilution with water, produced a solid dibromo derivative (m.p. 150–153° (dec.); calc. for $C_{23}H_{30}O_6Br_2$: Br, 28·42; found: Br, 28·67) which without purification was carried through the sodium iodide and sodium bisulphite steps as described above. Passage of the final product through a short column of ethyl acetate-washed alumina and two recrystallizations from acetone of the benzene–ether eluates yielded colourless needles of Δ^4-pregnene-3,11,20-trione-17α,21-diol 21-acetate (II*b*) (cortisone acetate), of melting point 236–238°, $[\alpha]_D^{20}$ + 181° (acetone), ultra-violet absorption maximum at 238 mμ (log ε, 4·35). The infra-red spectrum (chloroform) was identical with that of an authentic specimen.

While the overall yield in the conversion of the ketones I*a* and Ic to the adrenal hormones II was somewhat lower than observed earlier[2] in the androstane series, the present results clearly demonstrate the feasibility of synthesizing cortisone and other adrenal hormones from *allo*steroids of plant origin.

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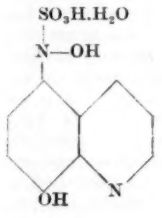
Antitubercular Activity of some 8-Hydroxyquinoline Derivatives

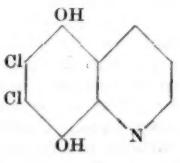
THE well-known antiseptic properties of 8-hydroxyquinoline, and particularly experiments on the use of this compound as an antitubercular agent[1], led one of us (T. U.) to prepare a few derivatives of 8-hydroxyquinoline, in order to examine their activity against *Mycobacterium tuberculosis*.

One of the products tested, *T* 28, proved to be particularly interesting due to its activity both *in vitro* and *in vivo* and to its low toxicity. The product was prepared by the action of sodium hydrogen sulphite on 5-nitroso-8-hydroxyquinoline. It proved to be monohydrate of N-sulpho-N-[5-quinolyl-8-hydroxy]-hydroxylamine (I), so far unknown in the literature.

A detailed description of the method of preparation and the proof of the structure will be reported elsewhere[2]. On boiling with concentrated hydrochloric acid, (I) was hydrolysed and, surprisingly enough, chlorinated, to yield the hydrochloride of 6.7-dichloro-5.8-dihydroxyquinoline (II).



I



II

The substance (II) also possesses strong antitubercular action *in vitro*, but experiments *in vivo* have not been carried out because of its high toxicity.

The other 8-hydroxyquinoline derivatives tested were: 5-amino-(III)- and 5.7-diamino-(IV)-quinoline. They were prepared in a new way—by reduction with sodium hydrosulphite of 5-nitroso- and 5.7-dinitro-8-hydroxyquinoline respectively. 5-Sulpho-8-hydroxyquinoline (sodium salt) (V) and 8-hydroxyquinoline sulphate (VI) were also tested and used as a standard.

The bacteriostatic concentrations were determined *in vitro* in Youmans's medium against six strains of saprophytic mycobacteria. Limits obtained for different strains are shown in Table 1.

Table 1

Substance	*T* 28 (I)	(II)	(III)	(IV)	(V)	(VI)
Bacteriostatic concentrations (mgm. per 100 ml.)	5–30	2	2·5–5	2·5–15	125–250	2·5–5

Table 2 shows the toxicity to rats of substances (I)–(V).

Table 2. LETHAL DOSE (GM. PER KGM. BODY-WEIGHT)

Substance	Intravenous injection	Subcutaneous injection	*per os*
T 28 (I)	1·0	1·5	*c.* 3·0
(II)	0·02	—	—
(III)	0·06	0·11	*c.* 0·5
(IV)	0·02	0·03	0·5
(V)	1·2	2·0	*c.* 5·0

The experiments carried out with Langendorf's rat's heart preparation showed that *T* 28 has no influence on the heart and coronary flow when 0·1 ml. of 5 per cent solution was administered. When given intravenously to a rabbit in doses of 50 mgm. per kgm. body-weight it caused only a small and temporary increase of the blood pressure. An injection of 50 mgm. per kgm. body-weight produced a fall of the sugar level by *c.* 20 per cent, lasting for 4 hr. Also only a very insignificant influence was observed on the peristaltic concentrations of the isolated rabbit's small intestine in a 0·1 per cent solution. No hæmolysis of rabbit red cells *in vitro* was observed.

Experiments *in vivo* were carried out by using guinea pigs (*c.* 500 gm.) inoculated intraperitoneally with 0·1 mgm. of *Mycobacterium tuberculosis* ($H_{37}Rv$ strain). The results are shown in Table 3.

Table 3

	No. of animals	Daily dose (mgm. per animal, subcut.)	Mortality (per cent)	Average tuber. index	Average survival time (days)
Streptomycin	20	8	10	57	84·4
T 28	20	10	40	64	76·1
Control	20	—	90	100	47·2

Treatment with *T* 28 and streptomycin started one week after inoculation.

The animals were treated for 42 days. They were then observed for a further 36 days; all survivors were killed, and the extent of tuberculous involvement was noted and rated.

Experiments on the clinical use of *T* 28 are being commenced.

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Preparation of the Optical Forms of Tris-Acetylacetone Cobalt III

IN an earlier communication[1], a number of experiments were described leading to the conclusion that the activities of enantiomeric ions could be changed to a different extent by the addition of an electrolyte containing an optically active anion or cation. In order to demonstrate the general applicability of this principle, we have sought to resolve a typical non-electrolytic complex salt without salt-forming groups. The peripheral atoms in the tris-acetylacetone cobalt III complex probably carry a slight negative charge, and hence negative or anionic asymmetrical fields are associated with the antipodal forms. The maximum differential interaction in solution is to be

expected with a multiply-charged optically active cation, and for the purpose *d*- and *l*-tris-ethylenediamine cobalt III iodides were used.

In the initial experiments, the acetylacetone cobalt complex was dissolved in 20 per cent chloroform in ether and extracted ten times with 2 per cent aqueous *d*-tris-ethylenediamine cobalt iodide, saturated with ether. The small portions dissolving in the aqueous layer were extracted completely with chloroform, which was then evaporated rapidly at room temperature. The small amount of green residue, in aqueous alcohol, was found to have a slight lævorotation.

In subsequent experiments, the acetylacetone complex (0·5 gm.) in 25 per cent aqueous alcohol (100 ml.), containing tris-ethylenediamine cobalt iodide (2 gm.), was heated to 60° C. for a few minutes, cooled to room temperature and allowed to stand for three days. The material that had separated (0·25 gm.) was found to be inactive. The filtrate cooled to 4° C. was fractionally treated with solid ammonium chloride to salt out the substance. The fractions, after washing with saturated ammonium chloride solution, were found to become increasingly lævorotatory. The most soluble fraction (0·03 per cent in 20 per cent aqueous alcohol) gave $\alpha = -0{\cdot}09°$. From this value, on a material probably not optically pure, $[\alpha]^{20}_{5461}$ is $-300°$. Similarly, with *l*-Co(en)$_3$I$_3$ the dextro form was obtained.

The rotation in the Na_D line was very small. Most of the substance had racemized in solution after twelve hours; but the solid was still active after three days.

The failure to detect both antipodes in any experiment demonstrated that the separation had been achieved through a 'first-order asymmetrical transformation'. In the presence of the *d*-Co(en)$_3^{3-}$ ion, the activity of the *l*-form of the acetylacetone complex was depressed more than the *d*-enantiomer, and the equilibrium between the antipodes moved until the activities were equal, that is, until there was an excess of the lævo form. The first-order asymmetrical transformation could be observed with difficulty as a mutarotation, but was confirmed by the addition of *d*-Co(en)$_3$I$_3$ to an aqueous solution of the complex, and, after standing for three days, extracting it completely with chloroform. The 0·047 per cent solution in chloroform had $\alpha = -0{\cdot}07°$. This result shows that, contrary to the opinion of Turner and Harris[2], first-order transformations do not require direct chemical combination between the 'activating agent' and the centre being 'activated'.

The optical forms of tris-acetylacetone chromium III, obtained in the same manner, were more stable than the cobalt compound, while the iron III compound had a very fleeting life. It is possible that the separation of the chromium III antipodes involved both a solubility difference and an asymmetrical transformation.

The work is proceeding and will be published shortly. Our thanks are due to Dr. D. P. Mellor for suggesting the acetylacetone complexes as typical non-electrolytes.

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Induction Periods in Reactions of N-Halogenimides

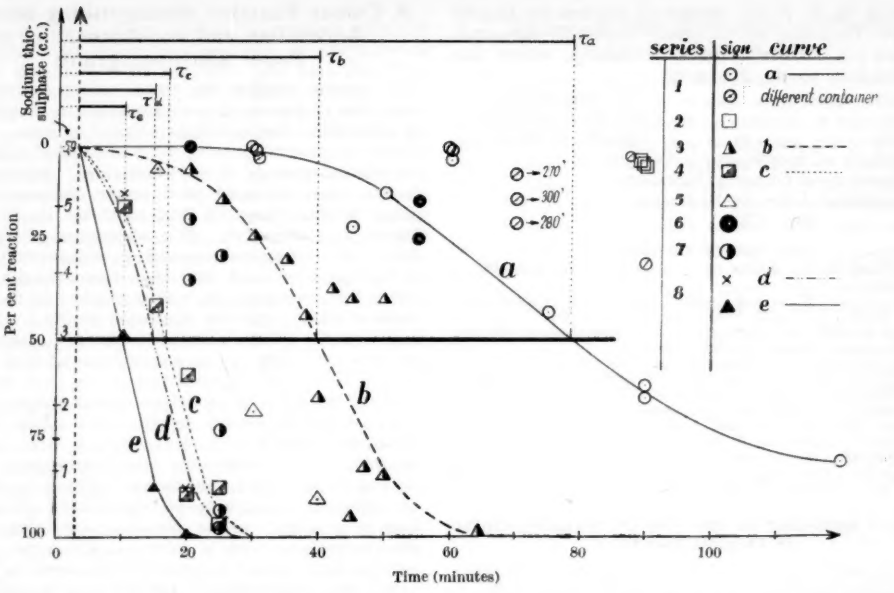
N-Halogenimides have been extensively used in preparative organic chemistry during the past few years[1]. We have attempted to elucidate the mechanism of the reaction of N-chlorosuccinimide on toluene, in which the simplicity of the reagents and products appeared to be particularly suitable for such a study.

On refluxing, in a quartz cell, a solution containing 0·08 mole of N-chlorosuccinimide per mole of toluene (b.p. 111°), we observed, in agreement with M. Hebbelynck and R. H. Martin[2], who first studied this reaction, a rapid photochemical reaction; irradiation was carried out with a 125-watt medium-pressure mercury lamp ('Philora', Philips) at a distance of 10 cm., giving an effective intensity of about 5×10^{-6} einstein/min./sq.cm. By the use of uranyl oxalate actinometry[3], we found a quantum yield of the order of 100 (the course of the reaction was followed by iodometry with $N/10$ sodium thiosulphate, if necessary following dilution with tetrachlorethane). At ordinary temperature, where the solubility limits the concentration to about 0·01 mole per mole of toluene, the quantum yield is of the order of unity. The photochemical reaction at ordinary temperature is of considerable interest, particularly in view of the fact that the photoactive component is toluene and not the N-chlorosuccinimide. It appeared necessary, however, to study first the *thermal reaction* at 110 ± 0·5° C. before attempting to interpret the quantum yield. Under conditions described above, but without irradiation, curve *a* shows the progress of the reaction as a function of time (series 1). Repetition of these experiments gave erratic results due to fortuitous conditions, such as the shape of the container used. But in all cases we noted induction periods at least as long as that illustrated in curve *a*, which should be considered as a limiting curve giving the maximum rate which is attainable under these conditions.

Considering the known inhibitory influence of oxygen on many halogenation reactions[4], we tried to degas the solution by passing oxygen-free nitrogen: this proved useless (series 2). We then carefully degassed the reagents under vacuum. After obtaining a gas pressure of less than 10^{-5} mm. mercury, at the temperature of liquid air, the bulbs containing about 4 c.c. of reaction mixture were sealed off under vacuum (series 3) and heated for varying times at 110° C. Under these conditions, curve *b*, which was very nicely reproducible, represents the course of the reaction. The half-reaction time falls from about 80 min. (τ_a) to 40 min. (τ_b).

Series 3 confirms the inhibitory effect of traces of oxygen, consumed during the initial phase of the reaction (induction period), and explains the erratic results obtained in the presence of air (series 1). Curve *b* still shows an induction period, even though its duration is markedly reduced.

We succeeded in nearly suppressing this induction period by means of a pre-treatment[5] (series 4, curve c, τ_c 17 min.). Bulbs containing N-chlorosuccinimide and toluene (prepared as for series 3) were heated during 180 min. and then broken under vacuum and their volatile constituents condensed on N-chlorosuccinimide in new bulbs. These new bulbs were then sealed off under vacuum and treated again as in series 3. Particular care was taken to eliminate all gases not condensed at liquid-air temperature.



The induction period in the experiments of series 3 could be due either to traces of impurities which are eliminated by the pre-treatment (series 4), or to the slow formation of a stable intermediate essential to the rapid progress of the reaction.

We confirmed the latter hypothesis by the following experiments :

(i) The effect of pre-treatment disappeared, at least partially (series 5), if the volatile constituents from pre-treatment are condensed by liquid air and then liquefied several times on a sodium mirror. Simultaneously we noted on the sodium the evolution of bubbles of a non-condensible gas equivalent to about 0·001–0·01 mole per mole of the N-chlorosuccinimide (pressure 10^{-1} to 10^{-2} mm. mercury in 1 litre). We assumed that it was most likely hydrogen and that the stable intermediate was hydrochloric acid.

(ii) Although the addition of dry hydrogen chloride gas in the presence of air is without effect (series 6), the addition of small amounts of anhydrous hydrogen chloride, carefully degassed by several sublimations in vacuum, shows a marked acceleration (series 7), in spite of the fact that chlorine is liberated in both cases.

Using amounts of hydrogen chloride measured with a gas pipette, the effect of the concentration (series 8, curve *d*, 0·003 moles hydrogen chloride/mole N-chlorosuccinimide; curve *e*, 0·009 mole hydrogen chloride/mole N-chlorosuccinimide) could be demonstrated; the induction period was thus reduced below the value obtained by the pre-treatment and probably practically abolished.

All these results seem to support the following mechanism :

(1) A small quantity of hydrogen chloride is formed probably by the reactions :

$$SNCl \rightleftharpoons SN\cdot + Cl\cdot \quad [SNCl = \text{N-chlorosuccinimide}]$$
$$Cl\cdot + H_2C{-}C_6H_5 \rightarrow ClH + \cdot H_2C{-}C_6H_5.$$

(2) It is known that :

$$ClH + SNCl \rightarrow Cl_2 + SNH.$$

(This equation is not meant to represent the mechanism of a reaction step but merely the known facts.)

$$Cl_2 \rightleftharpoons 2Cl\cdot$$

(3) Finally, the chlorine atoms favour a chain reaction by one or both of the following steps :

$$(a) \quad C_6H_5{-}CH_2\cdot + Cl_2 \rightarrow C_6H_5CH_2Cl + Cl\cdot$$
$$(b) \quad C_6H_5{-}CH_2\cdot + SNCl \rightarrow C_6H_5CH_2Cl + SN\cdot$$

One is thus led to a degenerate branching-chain mechanism of the type described by Semenoff[6]; such systems show long induction periods, followed by a reaction which may become explosive (bell-shaped rate curve).

It is known that reactions of this type are occasionally initiated with suddenness, and may sometimes result in accidents (see following letter). The effect of light would thus consist in the direct or indirect formation of chlorine atoms which, after having used up the oxygen, would initiate the branching chain. It appears, however, that several different phenomena remain to be elucidated before giving a concrete meaning to the 'mean chain-length' (quantum yield) which we have measured.

It would naturally be premature to generalize our results to all free-radical reactions of N-halogenimides. We do not believe, however, that we are dealing here with an exceptional case. Indeed, preliminary tests on the thermal reaction of N-bromosuccinimide on toluene show that this reaction is similar in nature (see, however, the experiments of Buu-Hoï[7] and Karrer[8] carried out in carbon tetrachloride solution). Furthermore, we observed in this case the transitory appearance of the coloration due to molecular bromine. This is obviously the reaction stage corresponding to step 2 in the above scheme.

We are following up the study of these thermal and photochemical reactions and hope to extend them, on one hand to true allylic systems, and, on the other, to different sources of atomic halogens[9].

One of us (P. A. G.) desires to express his thanks to the Institute of Applied Scientific Research (I.R.S.I.A.), Brussels, for a fellowship, which has enabled him to do this work.

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Dangers Attendant on the Use of N-Halogenimides in Organic Reactions

It is our duty, we believe, to direct the attention of research chemists to a tragic accident which should stand as a warning to all users of N-halogenimides. Our collaborator and friend, Dr. H. De Graef, who was a man of great experience and skill, was carrying out the chlorination of xylene by means of 1,3-dichloro-5,5-dimethylhydantoin, when a violent explosion occurred. Wounded and badly burned, De Graef survived only three days.

It is essential to remember that some of the reactions of N-halogenimides can be extremely violent even in the absence of peroxide. Several such reactions have been observed in this laboratory, namely :

N-chlorosuccinimide + benzylamine
N-chlorosuccinimide + aliphatic alcohols
3-nitro-N-bromophthalimide + tetrahydrofurfuryl alcohol.

Among cases reported in the literature the following may be mentioned here :

N-bromosuccinimide + hydrazine hydrate[1].
N-bromosuccinimide + diallyl sulphide[2].
N-bromosuccinimide + aniline[3].

In some cases we have noticed a vigorous evolution of chlorine or bromine in reactions carried out with 1,3-dichloro-5,5-dimethylhydantoin and 3-nitro-N-bromophthalimide respectively.

Peroxides must, of course, be handled with great care, and attention is directed, once more, to the danger of using chloroform, as recommended in the first edition of "Organic Syntheses"[4], for the recrystallization of benzoyl peroxide.

Every possible precaution should therefore be taken when using these reagents, and reactions of this type should be done on a small scale only.

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A Colour Reaction distinguishing between Adrenaline and *nor*-Adrenaline on Paper Chromatograms

In recent studies we were concerned with the detection of traces of *nor*-adrenaline in preparations of adrenaline derived from natural sources. Colorimetric methods[1,2] proved to be of limited value with low concentrations of *nor*-adrenaline ; but excellent results were obtained with paper chromatography, using modifications of the methods described by James and others[3,4]. The adrenaline samples are dissolved in methanol containing a minimum quantity of hydrochloric acid, and then transferred to paper strips for descending chromatography, or to circular disks of filter paper for chromatography by Rutter's technique[5]. Water-saturated phenol is used as the developing solvent in an atmosphere of hydrochloric acid[4]. The paper chromatograms are then dried and sprayed with an appropriate colour reagent.

The commonly-used ferricyanide colour reagent[3] produces browns and pinks which are not very sharply defined, especially when microgram quantities of *nor*-adrenaline are being sought in the presence of milligram quantities of adrenaline. More satisfactory results can be obtained by spraying the chromatograms with a solution of 0·5 gm. sodium β-naphthoquinone-4-sulphonate dissolved in 100 ml. of 0·2 *M* borate buffer at *p*H 8·9, the reagent having a final *p*H of 8·6. The solution should be freshly prepared just before use. With this reagent *nor*-adrenaline develops an intense blue colour slowly over a period of 15–30 min. Adrenaline produces a pink colour, while dihydroxyphenylalanine gives a yellow colour which gradually changes to a blue-grey. This colour difference should be of value in distinguishing dihydroxyphenylalanine from *nor*-adrenaline, since their R_F values are quite close[1]. At lower *p*H values (8·3–7·5), the paper background becomes badly discoloured, although the *nor*-adrenaline colour develops more rapidly. Exposure of the paper chromatogram to ammonia may be necessary before spraying if excessive amounts of acid are present.

This colour reaction is highly sensitive, being capable of detecting less than one microgram of *nor*-adrenaline per square centimetre of paper.

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Lamellar Compounds of Graphite with Chromyl Chloride and Chromyl Fluoride

The ability of graphite to form lamellar compounds by occluding certain other substances (fluorine, boron, oxygen, potassium, rubidium, caesium and ferric chloride) between its layer planes has been known for a considerable time. No new compounds of this type have, however, been reported for the past fifteen years, though attempts have been made to intercalate other volatile compounds in graphite. Thus Rüedorff and Schulz[1], who studied the ferric

chloride complex, were unable to prepare graphite complexes with either the triiodides or chlorides of arsenic, antimony and bismuth, and also failed to effect the intercalation of aluminium chloride. We have recently succeeded in preparing graphite complexes by the action of chromyl chloride and chromyl fluoride on graphite.

Qualitative tests showed that graphite swelled to almost twice its original size when warmed with its own volume of chromyl chloride. Even after thorough washing with carbon tetrachloride, in which chromyl chloride is readily soluble, a substance which analysis showed to be chromyl chloride could still be liberated from this treated graphite by heating the latter to between 200° and 300° C. This evolution was accompanied by exfoliation of the graphite and at least a hundred-fold increase in the volume of the latter.

The graphite used was a highly crystalline flake graphite from Uley, South Australia, purified by flotation and subsequent chemical treatment until its ash content had been reduced to less than 1 per cent. This material was screened into two fractions, the particle size being approximately 300 μ in one fraction and 40–80 μ in the other. Portions of each fraction were heated with four times their own weight of chromyl chloride at 100° C. for 24 hr., then washed with carbon tetrachloride and dried at 110° C. The products were analysed by first fuming with concentrated sulphuric acid, then ashing. The coarser sample was found to contain 43·0 per cent chromyl chloride and the finer 36·3 per cent. These large amounts are comparable with the amounts of ferric chloride held in the graphite–ferric chloride complex as found by Rüedorff and Schulz[1] and confirmed by Croft[2].

The exfoliation which accompanied the heating of these graphite–chromyl chloride complexes is typical of the lamellar compounds of graphite. Stability to solvents including aqueous acids and alkalis, which is a feature of the graphite–ferric chloride complex, is also shown by the new complex. Confirmation of the lamellar nature of this compound was obtained from X-ray diffraction measurements which showed that, as in the case of other graphite compounds, the carbon layer planes of the graphite are moved apart, in this instance from 3·45 A. to 9 A.

Following the intercalation of chromyl chloride, preparation of the corresponding fluorine compound was attempted with equal success. In this case it was found that graphite swelled immediately when placed in contact with chromyl fluoride at room temperature. Water-washed complexes obtained from this reaction exhibited an even greater degree of exfoliation than graphite–chromyl chloride when heated.

We wish to thank Mr. A. D. Wadsley for obtaining X-ray diffraction data for the graphite–chromyl chloride complex. A more detailed account of further studies on these complexes will be published elsewhere.

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Course of the Oxidation of Olefins by Chromic Acid

A further study of the oxidation of olefins by chromium trioxide in acetic anhydride[1] has now shown that the initial phase consists of two distinct reactions: (*a*) attack at a methylene group adjacent to the double bond; (*b*) oxidation at the double bond. The last reaction has been observed with all the olefins yet examined; allylic substitution (*a*) occurs to an appreciable extent with some olefins, with others it cannot be recognized.

The evidence for (*a*) is derived chiefly from a study of the oxidation of tetramethyl ethylene (I) and octene-1 (IV). 2 : 3-Dimethyl but-2-en-1-al (II) has been identified in the products of the oxidation of (I) by chromium trioxide in acetic anhydride; acetone and the monoacetate of 2 : 3-dimethylbutan-2 : 3-diol (III) are also formed. It is difficult to imagine that (II) can arise in any way other than by the attack of the oxidizing agent on the methyl group. This conclusion is reinforced by the observation that (II) is also formed from (I) by oxidation with selenium dioxide. Further support is given by the isolation of oct-1-en-3-one from octene-1 (V) from the products of oxidation by chromium trioxide in acetic anhydride.

The interpretation of the course of the oxidation at the double bond is not entirely unambiguous from observations on these olefins, in that fission occurs to a considerable extent. Clear evidence of the nature of the initial phase of the oxidation of the double bond is afforded by an examination of the behaviour of camphene (VI) and of di*neo*pentyl ethylene (VII). From both these olefins the corresponding epoxide has been isolated and is the major product of the oxidation.

$Me_2C{:}CMe_2$ (I) $\quad Me_2C{:}C(Me)CHO$ (II) $\quad Me_2C(OAc).C(OH)Me_2$ (III)

$CH_3(CH_2)_4.CH_2.CH{:}CH_2$ (IV) $\quad CH_3(CH_2)_4.CO.CH{:}CH_2$ (V)

The comparative stability of the epoxides from (VI) and (VII) no doubt permits of their survival during the reaction and the subsequent operations for isolating the products. Less resistant epoxides cannot survive, but it is possible in some cases to infer their participation in the oxidation; the presence of (III) in the products of the oxidation of tetramethyl ethylene finds a ready explanation on this basis.

$(CMe_3.CH_2)_2C{:}CH_2$ (VII) $\quad (CMe_3.CH_2)_2CH.CO_2H$ (VIII)

$CMe_3.CH_2.CMe{:}CH_2$ (IX) $\quad CMe_3.CH_2.CHMe.CO_2H$ (X)

$CMe_3.CH{:}CMe_2$ (XI) $\quad CMe_3.CMe_2.CO_2H$ (XII)

It is known that epoxides are also formed when some olefinic substances are oxidized in acetic acid by chromium trioxide[2–6], and it is a fair inference that the course of the reaction in acetic acid is the same as in acetic anhydride.

The extension of the idea of the initial formation of an epoxide to the oxidation by chromic acid in aqueous sulphuric acid has a serious difficulty; it is improbable that any epoxide is sufficiently stable to persist in aqueous sulphuric acid long enough to permit of its isolation. There are observations, how-

ever, which find a satisfactory explanation only if it is assumed that an epoxide is formed in the initial phase.

It is known that some olefins on oxidation by aqueous chromic acid in sulphuric acid give not only the expected fission products but also acids which contain the same number of carbon atoms as the original olefin. Thus, di*neo*pentyl ethylene (VII) gives a good yield of di*neo*pentyl acetic acid (VIII); 2 : 4 : 4-trimethyl pentene-1 (IX) gives the fission product *neo*pentyl methyl ketone as well as 2 : 4 : 4-trimethyl pentanoic acid (X); 2 : 4 : 4-trimethyl pentene-2 (XI) yields acetone and trimethyl acetic acid as well as 2 : 2 : 3 : 3-tetramethyl butanoic acid (XII). In all these examples it is known that the epoxide isomerizes to the aldehyde corresponding to the acid isolated; there is good qualitative agreement between the extent of this isomerization and the yield of the acid in the oxidation.

An alternative hypothesis based on the assumption that a glycol is the initial product of the oxidation is less satisfactory; the rate of oxidation of glycols is in general greater than their rate of isomerization.

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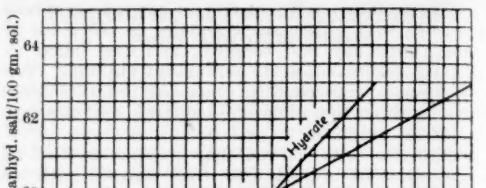
Solubility of Ethylenediamine D-Tartrate in Water

In a recent paper[1], A. C. Walker has given tables and curves for the solubility–temperature relationship in the system ethylenediamine D-tartrate (anhyd.)–ethylenediamine D-tartrate monohydrate–water. Dr. Walker shows that the salt decomposes slowly in solution, and the consequent change of composition of the solute during the time taken by the solubility determinations introduces some uncertainty in the results. Usually, when preparing a solubility curve, a considerable time must be allowed, at each observed temperature, for equilibrium between solution and solute to be attained. The change of composition of the solute during the experiments is probably responsible for the difference in level, of the order of 1° C., in two of the published curves.

In our work on growing large crystals of water-soluble substances, we have for some time been using a method for the direct estimation of the saturation temperature of solutions. The solution is circulated through a cell in which it is continuously brought into equilibrium with the solid phase being studied. Any departure from equilibrium in the cell is detected by observing a simple optical effect near the surface of a piece of crystal. The bulk of the solution is merely required to be uniform and free from solid; it is not necessary that it should at any stage be exactly at its saturation temperature.



We have used the procedure for obtaining the accompanying solubility curves of ethylenediamine D-tartrate and ethylenediamine D-tartrate hydrate. The solutions were prepared from the pure recrystallized anhydrous salt and distilled water only, so that the *p*H was approximately 6·0. The experimental conditions allowed about thirty points to be obtained in three hours for each curve. Decomposition of the solute in this period is slight, and we believe that our values are not in error by more than ± 0·1° C. It was found possible to follow the curves a considerable way into the regions where the solid phases studied are metastable only. To the extent to which they are shown in the graph, the curves are plotted from measured points and are not extrapolated.

It is intended to publish the method and results with more detail elsewhere.

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Complement Fixing Antigen in T5 *coli* Bacteriophage

Complement fixation with animal viruses has long been known, and Hoyle[1] by the use of the complement fixation reaction has demonstrated a soluble influenza virus antigen which appears in infected cells of the chick embryo prior to the time in the growth-cycle at which infective virus can be found. Up to the present time, so far as I am aware, complement-fixing antibody to the bacterial viruses has not been demonstrated, nor has there been sought in phage-infected cells material analogous to the soluble influenza antigen of Hoyle. However, a conversation with Sir Macfarlane Burnet prompted a search for such substances.

A rabbit serum obtained by immunization with the *coli* phage *T* 5 contained a high titre of complement-fixing antibody. The complement-fixing activity of broth preparations of *T* 5 was related directly to their titre of infective phage, reduction of the phage titre by filtration resulting in a parallel reduction in antigen titre. The phage antigen–antibody system behaved

like other large-particle complement-fixing systems. No zones of optimal antigen or antibody titre were found. Phage inactivated by heating at 73° C. or by precipitation with acid alcohol retained its antigenic activity. The antibody was specific for *1 5*, little or no crossing occurring with other phages of the *T* series.

One-step growth-curves of *1 5* in *coli B* in glucose veal broth with 0·001*M* calcium chloride showed a minimum latent period of 42 min. and completion of the cycle in 70 min., the average burst size varying from 100 to 200 particles per cell. The content of phage antigen and infective phage in the cells during the latent period was studied by the cyanide lysis technique of Doermann[2]. Cells grown in broth with aeration to a concentration of approximately 5×10^8 per ml. were infected at the rate of two phage particles per cell. 10-ml. aliquots were withdrawn at various times and unadsorbed phage removed by centrifugation. The unadsorbed phage content of the supernatant fluid was titrated, the fluid discarded and the infected cells resuspended in 1 ml. of broth with 0·02*M* sodium cyanide. This tenfold concentration of the cells was necessary to obtain amounts of phage which could be detected serologically. After lysis, the supernatants of the cyanide lysates were tested for infective phage and for antigen.

Nine minutes after infection, phage antigen but no infective phage could be recovered from the cells. At 12–20 min. after infection neither infective phage nor phage antigen could be detected. At 24 min. large amounts of antigen were found but no infective phage. After 25 min., infective phage and phage antigen were both found; but the titre of antigen was considerably greater than could be accounted for on the basis of infectivity. Thereafter, up to the end of the latent period, both infective phage and phage antigen increased in amount; but the quantity of antigen recovered was always greater than could be accounted for by the amount of infective phage freed by cyanide lysis.

These results may be interpreted as further evidence in favour of the hypothesis of disintegration of the invading virus particle[3]. They also demonstrate that during the early part of the latent period, not only does the virus lose its infectivity, but also its antigenic character disappears. This situation continues until half the latent period has passed, and then material can be detected in the infected cell which is not yet the complete infective virus but which has the antigenic character of the virus. In the light of our present knowledge of phage synthesis, it is significant that it is also at this stage that the deposition of significant amounts of virus deoxyribonucleic acid takes place.

This demonstration of the presence in phage-infected cells of material that can be measured by serological methods should prove of value in studies of the processes involved in chemical inhibition of phage production, and in reactivation of phage inactivated by ultra-violet light and X-rays.

A full account of the work will be published elsewhere.

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Effect of Antilymphocytic Serum on Suspensions of Lymphocytes *in vitro*

SERUM which has a powerful antilymphocytic effect *in vivo* can be prepared by immunizing an animal with injections of suspensions of heterologous lymphocytes[1,2]. The mechanism by which such a serum brings about a fall in the lymphocyte count when injected into an appropriate animal is uncertain, and it was felt that some light might be thrown on this question by studying the effect of the serum on suspensions of lymphocytes *in vitro*.

Antilymphocytic serum (rabbit-anti-rat) was prepared according to the method of Cruickshank[2], with one modification only, namely, that the immunizing injections were given subcutaneously instead of intraperitoneally. The serum was heated to 56° C. for 1 hr. to diminish anti-complementary activity. To test its efficacy, 2·0 ml. of the serum was injected intraperitoneally into a black-and-white hooded rat, total and differential leucocyte counts being made before and at intervals after the injection. A profound lymphopænia developed, the absolute lymphocyte count falling from 6,700 cells/c.mm. before, to 730 cells/c.mm. four hours after, the injection. On the other hand, no significant fall in lymphocyte count occurred in a rat which received an intraperitoneal injection of 2·0 ml. of normal rabbit serum.

For the *in vitro* test, suspensions of lymphocytes in Tyrode's solution were prepared from lymph nodes of black-and-white hooded rats, as described by Cruickshank. The cells were washed four times with Tyrode's solution and the final suspensions adjusted to a count of approximately 40,000 lymphocytes per c.mm. 0·4 ml. of suspension was placed in each of six glass ampoules (2·0 ml. capacity) and to these was added, respectively: 0·4 ml. antilymphocytic serum; 0·4 ml. antilymphocytic serum and 2 M.H.D. guinea pig complement; 0·04 ml. antilymphocytic serum, 0·36 ml. Tyrode's solution and 2 M.H.D. complement; 0·4 ml. normal rabbit serum; 0·4 ml. normal rabbit serum and 2 M.H.D. complement; and 0·04 ml. normal rabbit serum, 0·36 ml. Tyrode's solution and 2 M.H.D. complement. After samples had been removed for counting, the air in the ampoules was replaced by a mixture of 95 per cent oxygen and 5 per cent carbon dioxide and the ampoules were sealed. They were then attached to a mechanical mixer of the rotating drum type, which was placed inside the incubator (37° C.) and allowed to turn very slowly (10 r.p.m.). Further samples for counting were taken after 2 hr. and again after 18 hr. incubation.

The cell counts were made in a hæmacytometer after dilution with a solution of eosin in Tyrode's solution (1 in 2,000), as described by Schrek[3], the total count and the proportion of stained cells being recorded in each case. As the accompanying table indicates, none of the total counts showed any significant change following incubation. The proportion of stained cells—dead cells according to Schrek—increased slightly but to approximately the same extent in each case.

It thus appears that antilymphocytic serum has no effect on suspensions of lymphocytes *in vitro*. This suggests that the action of the serum *in vivo* is probably not due to direct destruction of lymphocytes in the blood stream.

Our observations are at variance with those of some other workers[4] who have reported agglutination

Type of serum	Final dilution of serum (per cent)	Whether complement added	Lymphocyte counts					
			Pre-incubation		After 2 hr. incubation		After 18 hr. incubation	
			Total count	Proportion of stained cells (per cent)	Total count	Proportion of stained cells (per cent)	Total count	Proportion of stained cells (per cent)
Normal	50	No	17,150	21	17,650	21	20,150	57
Normal	50 approx.	Yes	21,150	22	20,100	24	17,050	60
Normal	5 approx.	Yes	19,000	26	17,700	31	17,050	70
Antilymphocytic	50	No	14,850	36	13,100	41	15,000	71
Antilymphocytic	50 approx.	Yes	18,450	36	20,950	34	21,800	70
Antilymphocytic	5 approx.	Yes	21,750	35	18,900	36	18,550	54

of lymphocytes *in vitro* by antilymphocytic sera; but the tests they describe are difficult and notoriously liable to give falsely positive results. Admittedly, in our experiments continuous mixing of the suspensions occurred; but this was extremely gentle and not likely to have masked the effect of agglutinating antibodies had such been present.

It is of interest that Robertson[5] found that adrenal cortical extracts, which were markedly antilymphocytic *in vivo*, also had no apparent effect on lymphocytes *in vitro*. It is true that Robertson relied on counts of total number of cells only, and more recently Schrek[6] has claimed that some significant change in the proportion of stained cells does occur after incubation with cortical extracts; but the effect was very slight and would not seem to afford any explanation of the lymphopænia which this material produces *in vivo*.

Since antilymphocytic serum and cortical hormones both cause a marked lymphopænia on injection, but have little or no effect on lymphocytes *in vitro*, it might be suggested that the *in vivo* effect of the serum is mediated solely by an adrenal cortical mechanism. This, however, is not the case, since we have found[7] that the antilymphocytic effect of the serum, though possibly diminished, is still apparent in adrenalectomized animals.

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Vitamin B_{12} Content of Soft- and Hard-shell Clams

Microbiological assays for vitamin B_{12} content were made on soft-shell clams (*Mya arenaria*) and hard-shell clams or quahaugs (*Venus mercenaria*) from the waters off the coast of Massachusetts and Rhode Island. Assays were also made on commercially canned clams, both whole and minced, and on calf, beef, and pig livers obtained through normal retail outlets.

The samples, diluted 1 : 100 with distilled water, were disintegrated in a Waring blendor and extracted under benzene at 55° C. for 24 hr. More efficient extraction of vitamin B_{12} was thus obtained than by slurrying in a Waring blendor and immediately assaying[1]. One sample of soft-shell clams was lyophilized before being extracted; the material was frozen with a mixture of solid carbon dioxide and alcohol (− 78° C.) and dried at the resulting low temperature for 15 hr. *in vacuo* (pressure, 0·2 mm. mercury).

The assay tubes were prepared in the usual manner for microbiological assay. The basal medium employed was that of Winsten and Eigen[2], except that 0·5 gm. of vitamin C was added per litre of medium. *Lactobacillus leishmanii* 313 (*ATCC* 7830) was used as the test organism. Titrimetric evaluation of the response of the test organism was made with $N/10$ sodium hydroxide, bromthymol blue being used as an internal indicator. Duplicate tubes containing 10 ml. of assay solution were used at four levels of sample material, and the results for the series were averaged. Maximum response was obtained at 0·4 μgm. of vitamin B_{12}.

All the fresh samples of soft- and hard-shell clams had higher contents of vitamin B_{12} (6·0–9·7 μgm. per gm. of dry weight) than any of the animal livers assayed (1·3, 1·1 and 2·6 μgm. per gm. of dry weight, for pig, beef and calf liver, respectively). That clams are a richer source of this vitamin than animal livers may be of some importance in pernicious anæmia therapy.

Assays for dissected portions of soft-shell clams indicated that the visceral mass contained a higher concentration of vitamin B_{12} (16·3 μgm. per gm. of dry weight) than other parts of the clam assayed (2·0 μgm. for foot and siphon and 2·1 μgm. per gm. for the remainder).

The entire vitamin B_{12} content of the dissected soft-shell clams as calculated from weighted averages of the values for the dissected portions was confirmed within experimental error by the concurrent assay of an undissected duplicate.

The drained solids of the commercially canned whole clams contained only about half as much vitamin B_{12} on the dry basis (3·8 μgm. per gm.) as the fresh clams. It is uncertain whether some of the vitamin B_{12} activity of the canned material was lost during processing, or whether the lower vitamin content was due to a difference in species or locality of collection.

Canned minced clams assayed about 50 per cent lower in vitamin B_{12} content of drained solids than did canned whole clams. This lower vitamin content may possibly be explained by the fact that the visceral mass is removed from clams before they are minced for canning and, as already pointed out, there is a higher concentration of vitamin B_{12} in the clam's digestive tract. It now appears that this discarded material might be an excellent source of vitamin B_{12} for animal-feed supplements.

The lyophilizing process had no detrimental effect on the vitamin B_{12} potency of soft-shell clams. If clams are found useful for therapeutic purposes, this fact is of interest, because large amounts can be conveniently prepared for storage in this manner.

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Use of a Sheep Abortion Virus as a Test Virus for Chemotherapy Work

A STRAIN of abortion virus, isolated by us from a local case of sheep abortion in March 1950 and apparently similar to the virus isolated by Stamp, McEwen, Watt and Nisbet[1], has been extensively used in an *in ovo* 'screening test'. It has proved so satisfactory for this purpose that it is felt its usefulness should be more generally known. The virus in infected membranes remains viable indefinitely at − 20° and for some weeks at 0°, and regularly produces well-defined lesions on the chorioallantoic membrane; in both these respects it is superior to many other large viruses. So far as is known, it is not pathogenic to man.

Drug	Inhibitory dose (mgm./egg)		* Activity in mice against Nigg virus (drug given subcutaneously from day of infection)
	Abortion	Nigg	
Chloromycetin	1·0	2·0	++ (0·02 mgm./gm./day)
Aureomycin	0·25	0·25	+++ (,,)
Terramycin	0·06	0·06	+++ (,,)
Penicillin	Inact. 2,000 u.	2,000 u.	+ (4,000 u./mouse/day)
Sulphathiazole	Inact. 14·7	14·7	+ (0·2 mgm./gm./day)
p-Aminobenzoic acid	Inact. 27·4	Inact. 13·7	0 (2 mgm./gm./day, orally)

* + = prolongation of life only; ++ = no deaths, but lungs involved; +++ = no deaths, lungs not involved.

Groups of 10-day chick embryos are used for the test. The drug, in 0·2 ml. diluent containing 1,000 u. penicillin and 1,000 u. streptomycin per ml., is introduced into the yolk sac; 0·2 ml. of a broth suspension of the virus is inoculated on to the chorioallantoic membrane within four hours. After a further seven days incubation, the membrane is removed and, since the lesions are very distinct, readily assessed.

To date 250 compounds have been tested, but only terramycin, aureomycin and chloromycetin have been found active.

It is probable that the abortion virus is related to the psittacosis group. To test this hypothesis an investigation into the effect of drugs on mouse pneumonitis (Nigg) virus was carried out under the same test conditions; results are given in the accompanying table. Both viruses are sensitive to terramycin, aureomycin and chloromycetin, but the abortion virus, unlike Nigg virus, is not attacked by penicillin or sulphathiazole; the implications of these results are being studied further. Full details of the work will be published elsewhere and evidence presented to justify the belief that this type of *in ovo* test will detect compounds likely to be of chemotherapeutic value. It requires smaller amounts of drug and provides indications similar to those yielded by the more laborious mouse tests (see table).

We wish to thank Sir Jack Drummond and Mr. C. E. Coulthard for their interest in this work, and Dr. A. D. McEwen for much information.

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Is Age of Parents Important in Sheep?

A SITUATION provoking speculation has been found during the course of a preliminary investigation of one-shear (1½-year old) rams offered for sale at the Feilding Stud Ram Fair. Stock entered in the Fair, the most important of its kind in New Zealand, come from the Manawatu and neighbouring Wairarapa and Hawke's Bay districts and are purchased by breeders throughout New Zealand, Australia and South America. Data used in these analyses were derived from the catalogues of the 1948, 1949 and 1950 sales and the 1948 Flock Book of the New Zealand Romney Marsh Breed Society.

Of the 612 rams offered for sale in the three years, 52·6 per cent were sired either by lambs or by one-shear rams. The offspring of the one-shear rams brought the highest average price and had a lower rejection-rate than any other age. Similarly, an analysis of the 1948 Flock Book involving all Romney stud sheep in the Dominion shows that 49·5 per cent of the 1,580 rams single-entered (that is, to be used as stud sires) were sons of either ram lambs or untried one-shear sires. However, Goot[1] has shown that one-shear sires comprise only 27·8 per cent of the sires available for use in those flocks static in numbers and consisting of 400 or more ewes.

Selection of rams for the Stud Fair and for single-entry in the Flock Book is almost solely on phenotype and certainly without reference to age of the parents, nor does this latter point interest buyers. Because of this, it would be expected that the sires of rams chosen for single-entry and for sale would be represented in the same proportion as they are used in the flocks. In this case only 27·8 per cent of the rams single-entered or offered for sale would be the sons of one-shear rams. However, the results show that they produce almost twice this number.

An analysis of the influence of age of dam shows that progeny of the youngest ewes achieve the highest average price, though the proportion of these is not greatly different from that expected from the age composition of dams[1].

For every sire recorded in the sale catalogues there are on an average a little less than two sons offered for sale.

Further analyses are planned to throw more light on these rather perplexing problems.

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Biochemistry in the Taxonomy of Lichens

The application of biochemical methods to plant taxonomy was first made in the lichens, in 1867, when potassium hydroxide and calcium hypochlorite were found to give characteristic colour reactions when applied to the thallus of certain species. Most present-day lichenologists employ these reactions as an important character in the description of species. In a large number of lichen species the exact constitution of the lichen acids causing colour reactions is known, mainly owing to the researches of Zopf[1] and Asahina[2,3]. The latter has originated a method of microchemical analysis whereby the lichen acids can be determined by the form of the crystals which they produce under the microscope when recrystallized from various solutions[4], this method requiring the extraction of only a small portion of the thallus with acetone.

Use has been made of biochemical methods as an aid to taxonomy also in the flowering plants, and it has been found that many of the larger groupings, such as families, sections and genera, originally delimited on a purely morphological basis, are characterized also by biochemical differences[5]. The application of chemical methods in Phanerogams, however, has not yet reached the point at which species are distinguished on chemical characters. Penfold, Morrison and Smith-White, for example, class individuals of the Australian tree *Leptospermum citratium* containing different essential oils as "variety A" and "variety B" respectively[6]. In lichens, the tendency has been to regard chemically distinct individuals as distinct species, irrespective of whether morphological differences are present or not. This view, if carried to its logical conclusion, means that in many cases related species could be determined only by chemical analysis. This state of affairs has already been reached in certain lichen genera, for example, *Cladonia*. In the lichens the matter is further complicated by the fact that they are not simple organisms, but a fungus–alga consortium, and in most cases it is not known with certainty to what extent the formation of the characteristic lichen acids depends on the symbiotic union. In a few cases the fungal component has proved capable of producing the characteristic substance in pure culture without Algæ[7]. It is not unlikely that the same lichen fungus may produce distinct acids in symbiosis with different Algæ. The differentiation of 'chemical species' in the lichens therefore rests on a doubly insecure foundation.

The problem has already become acute in the taxonomy of lichens to the extent of forming a serious obstacle to the work of classification; for example, in one genus now under monographic study, it would be necessary to describe more than forty 'new species' on chemical grounds alone, without supporting morphological characters, if the present conventional treatment were adhered to. The increasing interest shown by taxonomists in other plant groups in the use of biochemical methods makes it necessary, if possible, to forestall difficulties of a similar nature which will undoubtedly arise as further use is made of biochemical criteria applied to taxonomy.

It is now suggested that morphologically indistinguishable individuals of plants (other than bacteria) which differ in their chemical characters should be included in the same species as distinct 'chemical strains', the nature of the compound present being indicated in brackets, together with quotation of the taxonomic epithet previously used (if any) to designate the strain in question. The following are some examples of the treatment applied to lichen species:

Stereocaulon tomentosum Fr., Ch. str. I (stictic acid or typical strain).
" " " Ch. str. II (lobaric acid or 'sasakii'-strain) (previously described as a distinct species, *St. Sasakii*).
Cladonia chlorophæa (Flk.) Spreng., Ch. str. I (fumarprotocetraric acid or typical strain).
" " " " Ch. str. II (grayanínic acid or 'grayi'-strain).
" " " " Ch. str. III (cryptochlorophæic acid or 'cryptochlorophæa'-strain).
" " " " Ch. str. IV (merochlorophæic acid or 'merochlorophæa'-strain).
" " " " Ch. str. V (novochlorophæic acid strain).
" " " " Ch. str. VI (usnic acid strain).

The strains containing grayaninic, cryptochlorophæic and merochlorophæic acids had been previously designated as distinct species with the names *grayi*, *cryptochlorophœa* and *merochloroplœa* respectively.

The application of this method registers the chemical differences while keeping them outside the framework of formal taxonomy, and thus avoids burdening the latter with a mass of unnecessary epithets. It also enables the field-worker to determine his species on a morphological basis. Continued attention should, however, be paid to the constitution and distribution of the distinct chemical strains, for they have been found, at any rate in some of the lichens, to be significant for distribution, occurring in separate parts of the species' geographical area.

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Feb. 1.

[1] Zopf, W., "Die Flechtenstoffe in chemischer, botanischer, pharmakologischer und technischer Beziehung" (Jena, 1907).
[2] Asahina, Y., *Acta Phytochim.*, **8**, 47 (1934).
[3] Asahina, Y., *Bot. Mag., Tokyo*, **51**, 759 (1937).
[4] Asahina, Y., *J. Jap. Bot.*, **12**, 516, 859 (1936); **13**, 529, 855 (1937); **14**, 39, 244, 318, 650, 767 (1938); **15**, 465 (1939); **16**, 185 (1940).
[5] Gibbs, R. D., *Trans. Roy. Soc. Canada*, Sect. 5, **39**, 71 (1945).
[6] Penfold, A. R., Morrison, F. R., and Smith-White, S., *J. and Proc. Roy. Soc. N.S. Wales*, **76**, 93 (1942).
[7] Thomas, E. A., *Ber. schweiz. bot. Ges.*, **45**, 191 (1936).

Permanent Preparations of Fungi Growing on Agar

The methods to be described here have been used in making preparations of predacious fungi from agar cultures, where it is important that hyphæ should be retained *in situ*; but they also appear to be generally applicable.

For making rapid preparations from living material, a modification of the chlorazol black method of Armitage[1] has been found satisfactory. From material growing in culture, agar blocks about 4 mm. square are cut out with a scalpel, and the surface of the agar bearing the fungus is carefully sliced off with a razor blade to a uniform thickness of about 200 μ. The treatment is then as follows: fix in absolute alcohol, 1 min.; stain in a saturated methyl alcohol solution of chlorazol black E, 1 sec.; dehydrate in absolute alcohol, 10 min.; mount in 'Euparal' in a cavity slide, and harden by gentle heat.

This method is excellent for mycelium and thick-walled spores; but large thin-walled spores are apt to collapse as a result of the rather drastic treatment. As Armitage[1] points out, the chlorazol black stains more brilliantly if methyl alcohol is used as solvent rather than ethyl alcohol.

The thickness of the agar included in the preparation is sometimes a source of trouble in critical observation with high-aperture objectives. To avoid this, the following technique may be used which, though slower, gives beautiful preparations. Blocks of agar bearing the fungus, about 4 mm. square, are cut out and fixed in the following mixture: commercial formalin, 10 ml.; glacial acetic acid, 5 ml.; distilled water, 85 ml. For this formula we are indebted to Dr. B. Barnes. Material is fixed for at least 24 hr., but may be left in the fixative indefinitely without harm. The agar block is washed until it no longer smells of acetic acid, and then stuck, fungus downwards, on a No. 1 cover slip by means of Szombathy's gelatine, as recommended by Chamberlain[2]. The agar is allowed to dry in a warm place (not above 35° C.) until it begins to shrink; the surface bearing the fungus is prevented from shrinking by adhesion to the glass. When the agar is firmly attached to the cover slip, the block is sliced away with a sharp razor blade as close to the glass as possible. The material, still on the glass, is then stained with Heidenhain's hæmatoxylin, dehydrated by passage through a gradually ascending series of alcohols, cleared with terpineol and mounted in canada balsam. If desired, clearing may be omitted and 'Euparal' used as a mountant following absolute alcohol.

In this technique, any suitable stain may be used, but once alcohol has been applied to the preparation it is inadvisable to return to water, as swelling of the agar may cause it to become detached from the glass.

Details of these and other techniques will be given elsewhere.

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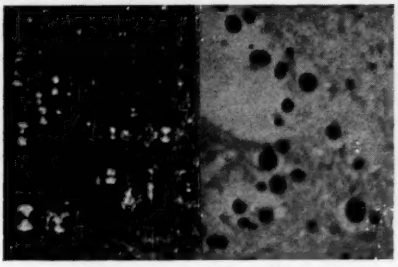
[1] Armitage, F. D., *Trans. Brit. Mycol. Soc.*, **27**, 131 (1944).
[2] Chamberlain, C. J., "Methods in Plant Histology" (Chicago, 1932).

Corpora amylacea in the Central Nervous System

It has long been known that small round corpuscles may be found around the blood vessels of the central nervous system in subjects of advanced age. As the staining properties of these bodies are similar to those of starch, Virchow called them corpora amylacea. Several authors have examined them in attempts to determine their origin, but without definite result. The present contribution describes an attempt to define the morphology and some of the chemical properties of corpora amylacea, using the polarizing microscope as well as the periodic acid–leucofuchsin method[1].

Under the polarizing microscope, the round bodies show pronounced double refraction with a positive Maltese cross (Fig. 1), the path-difference being 15–20 μ in our sections. This finding does not agree with those previously given in the literature[2]. The character of the double refraction does not change in the imbibition test, suggesting that self-birefringent lipids may be considered as the principal constituents of these bodies.



(1) (2)

Sections of corpora amylacea: (1) polarized light, crossed nicols and Senarmont compensation (× 80); (2) periodic acid-leucofuchsin method (× 80)

The myelin sheath gives a positive aldehydic reaction after treatment with periodic acid; the round bodies were treated similarly in order to obtain information about the possibility of a genetical relationship between them and the myelin sheath. Frozen or paraffin-embedded sections of corpora amylacea showed a brilliant rose-purple colour (Fig. 2); myelin sheath, however, gave a positive result only in frozen sections. In the case of corpora amylacea, the reaction was not inhibited if the bodies were extracted with solvents which would remove cerebrosides. This is probably due to the fact that the cerebrosides which are responsible for the aldehyde reaction are linked to proteins, thereby becoming unextractable[3].

Summarizing the above results, it is suggested that the principal constituents of corpora amylacea are lipids, and that their intense aldehydic reaction after treatment with periodic acid indicates that they possibly belong to the carbohydrate-containing cerebrosides. It well may be that the origin of corpora amylacea is in the cerebrosides of the degenerated myelin sheath.

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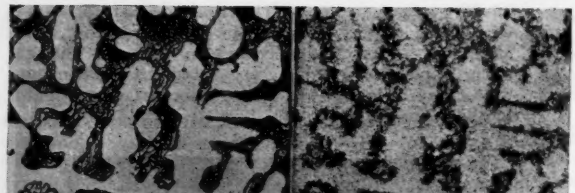
[1] McManus, J. F. A., *Nature*, **158**, 202 (1946).
[2] Pullinger, B. D., *J. Path. Bact.*, **55**, 99 (1943).
[3] Morrison, R. W., and Hack, M. H., *Amer. J. Path.*, **25**, 597 (1949).

Nuclear Reaction Radiography

Autoradiography has been employed for many years for the purpose of determining the distribution of an element in a given material. The essential requirement for the use of this method is that the element in question itself should emit a radiation which can be registered on a photographic film pressed against the surface of the sample. To make an element betray its presence in this way, one provides a certain fraction of marked atoms by adding a small amount of radioactive isotopes of the same element.



(*a*) Photomicrograph of the metal surface. Light areas: iron; darker parts: eutectic of iron and Fe_2B. × 100

(*b*) Reaction radiograph of the same surface as that shown in (*a*). Dark spots are produced by α-particles, showing position of reacting atoms of boron. × 100

I have investigated another method, which may be termed nuclear reaction radiography, since it makes use of the property of the non-radioactive element in question of reacting with an external particle radiation in such a way that a new radiation is born in the process, which is then registered on the photographic film. To use this method, the photographic film must be insensitive to the primary particle radiation used for exciting the reaction. This requirement would seem to restrict the species of available primary radiations at present to one kind, namely, neutrons. Another requirement is that the element to be detected should have a much higher probability of reacting with the primary radiation than other elements present in the material under investigation. This can be achieved in some cases by the choice of neutrons with suitable energy, making use of the fact that different reactions have different resonance energies. Finally, the radiation produced in the reaction must be of such a nature that it can be properly registered on the film.

Boron is one of those elements where the ordinary autoradiographic method fails, since no suitable radioisotope is available. Instead, conditions would seem to be favourable for the use of nuclear reaction radiography in this case. The reaction which suggests itself is:

$$_5{}^{10}\mathrm{B} + {}_0{}^1n \rightarrow {}_3{}^7\mathrm{Li} + {}_2{}^4\alpha.$$

For thermal energy neutrons, the cross-section has the very high value of 3,000 barns. The α-particle is emitted with an energy of 1·5 MeV., which is a very favourable value for photographic trace production. The range of these particles is about 5 μ in the emulsion, and in iron it is considerably less than this. Hence, the method should be capable of yielding very high resolution. I have investigated this method, using Kodak Autoradiographic plates. These photographic plates should give very good resolution because (i) the emulsion is very fine grained, (ii) the emulsion can be stripped from the glass plate and mounted directly on the sample under investigation. A further advantage with this material is that the sensitivity to γ-radiation is very small, whereas the sensitivity to α-radiation is high.

The method has been tested on an experimental alloy made up of 98 per cent iron and 2 per cent boron. A small sample of this was ground, polished and etched, and given a thin protective coating of collodion in order to keep the surface free from tarnish in the subsequent work (otherwise it will rust very readily). The collodion film was less than 1 μ thick. The freshly stripped, wet emulsion was placed on top of this and was allowed to dry in position, which made it adhere firmly to the sample. The sample was then placed in a light-tight container, where it was irradiated for 16 min. with neutrons from a cyclotron. A block of lead, inserted between the sample and the cyclotron, served to reduce as much as possible the amount of γ-radiation reaching the emulsion. The sample was surrounded by paraffin wax in order to obtain a favourable proportion of thermal neutrons. After irradiation, the emulsion was developed and compared with the metal surface in an ordinary microscope. The results are illustrated by the accompanying reproductions. It is evident that the emulsion stripped from the sample reproduces the distribution of boron quite accurately, and that it is possible to work at quite considerable magnification.

I am grateful to the Nobel Institute for Physics in Stockholm, where Mr. S. Thulin kindly carried out the cyclotron irradiation, and to Mr. L. Erwall of the Division of Physical Chemistry at the Royal Institute of Technology, Stockholm, who placed the Kodak Autoradiographic plate material at my disposal; this emulsion undoubtedly played an important part in the success of this experiment.

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April 12.

The Point-Charge in the Non-symmetric Field Theory

Gaganbihari Bandyopadhyay's remark[1] about one of the spherically symmetric static solutions, that were given in a paper by one of us[2], is interesting, but it has not the meaning this author attributes to it. This solution cannot possibly refer to an electric charge at the centre, but only—if to anything electromagnetic—to a magnetic charge, that is, to an isolated magnetic pole. Indeed, the one component to which the six-vector is reduced in this solution is radial and is labelled by the indices 1 (referring to the radial direction) and 4 (referring to time). Now, in contrast to the conventional labelling, the present theory has to identify the electric field with the three components of the six-vector that do *not* include the index 4 (*if* the skew part of g_{ik} is to represent electromagnetism). The reason is that the theory definitely yields one and only one set of four Maxwellian vacuum equations. This set has to enunciate the vanishing of the *magnetic* four-current, not of the electric one; and this imperatively demands the association of labels indicated above. We may add that the necessity to reverse the convention is very satisfactory and is, in itself, likely to strengthen our confidence in the new theory. Indeed, very good reasons for reversing the conventional association were pointed out by Einstein[3] long ago and repeated by one of us[4] since.

Thus Bandyopadhyay's remark[1] really means that an isolated magnetic pole, attached to a finite mass,

is impossible according to the more stringent version, proposed by Einstein lately[5], of the non-symmetric theory. We might strengthen this argument by saying that, to introduce as a singularity what the field equations definitely disallow where they hold, was a daring enterprise anyhow, justified only by the endeavour to investigate, at the then undeveloped stage of the theory, *all* spherically symmetric solutions.

But what about the electrically charged mass-point ? The same paper[2] (§§ 8 and 9) fully discusses this case as well, though it is analytically far more intricate and has only recently found its explicit expression (see Wyman[6]). It is gratifying to find that the only reasonable solution with a radial *electric* field is not only *compatible* with Einstein's recent more stringent version, but, of necessity, complies with it (see equations 30*b* and 23, *l.c.*[2]).

To sum up : the new theory exhibits a pleasing lack of symmetry with regard to electric and magnetic quantities. Even in its most stringent form it admits of electrically charged mass-points, while isolated magnetic poles are well-nigh inadmissible in any form of the theory.

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[1] *Nature*, **167**, 648 (1951).
[2] Papapetrou, A., *Proc. Roy. Irish Acad.*, **51** (A), 163 (1947).
[3] *Sitz. Ber. d. Preuss. Akad.*, 414 (1925).
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Effect of Cross-wind on a Projectile

The usual formula for drift of a projectile due to cross-wind is :

$$z = w\,(t - x/v)\ \text{(ft.)}, \qquad (1)$$

where w is velocity of cross-wind (ft./sec.), t is time of flight (sec.), x is range through air (ft.), v is muzzle velocity relative to the air (ft./sec.). At short times of flight it is not always easy to calculate $(t - x/v)$ with reasonable speed and accuracy.

By integrating the equation of motion along the trajectory

$$m\ddot{x} = -\rho\,(v^2 + w^2)\,v^2 f_R, \qquad (2)$$

where m is mass of projectile (lb.), x is range along the trajectory (ft.), ρ is air density (lb./ft.^{3}), r is radius of projectile (ft.), f_R is drag coefficient, and v, w are as in (1), expanding in series and substituting in (1), we obtain

$$z = 0{\cdot}000067\ wvt^2\ d^2 f_R/m\ \text{(ft.)}. \qquad (3)$$

Equation (3) is easy to use, but is valid at short times of flight only. The result is better at subsonic velocities than at supersonic velocities.

It is hoped that a full account of this will appear elsewhere.

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Feb. 15.

Negative Point-to-Plane Corona—a New Mode of the Discharge

A number of investigators[1,2] in the field of negative point-to-plane corona have reported on the unsteady nature of the discharge at high values of gap voltages. Reference has been made to the movement of the active-spot about the point, and the formation of 'plural spots'. I have found that, with certain gap geometries, a new mode of discharge can be observed.

As the applied voltage is increased, the point discharge passes through an unstable 'switching phase', sometimes with two or more active spots, but quickly settles down to the new mode. This consists of a ring-shaped discharge fitting neatly and symmetrically about the point, almost like a halo. Its structure is similar in appearance to that of the single spot, namely, a miniature glow discharge, with a negative glow of pronounced luminosity, a Faraday dark space, followed by a diffused and flared positive column. As yet I have been unable to achieve sufficient optical resolution to observe the Crookes's dark space.

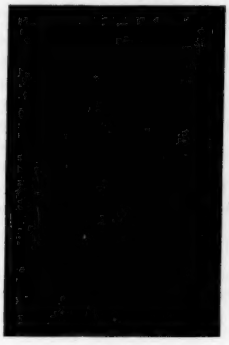

Fig. 1

It is obviously impossible to obtain a direct view on to the tip of the point, the line of vision being obscured by the plane ; however, by using a highly polished plane, the image of the point and the discharge, in the plane, may be readily seen with the aid of a suitable optical system. Observations are best carried out in total darkness with a dark-adapted eye.

Fig. 1 shows a photograph of the ring on a 1-mm. diam. steel point, taken in this way ; the point-to-plane gap was 10 mm., and the applied voltage and mean current were 10·9 kV., and 65 μamp., respectively. Fig. 2 shows a sketch of the point, drawn to the scale of Fig. 1, for the purpose of comparison.

In its new mode, the pulsating character of the corona persists, but oscillographic measurements

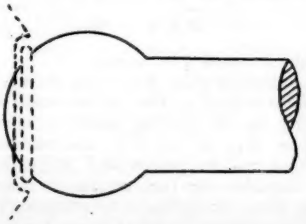

Fig. 2

indicate an apparent discontinuity in the frequency characteristic. A change in the mean current/gap voltage relationship, resulting in an increase in the charge per burst, is also evident.

A likely explanation of the phenomenon, which has so far gained considerable experimental support, is to be found in an extension of Loeb's[3] theory on the mechanism of Trichel pulses; that is to say, the new mode is engendered by space-charge considerations, as distinct from changes in Townsend's second coefficient, γ, for example.

A fuller report and discussion on the subject will be published in the near future.

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[1] Trichel, G. W., *Phys. Rev.*, **54**, 1078 (1938).
[2] Loeb, L. B., and Kipp, A. F., *J. App. Phys.*, **10**, 142 (1939).
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A Relationship between Heat Conductivity and Viscosity of Liquids

Andrade[1] developed a theory of viscosity of liquids based on a model in which the molecules are regarded as executing vibrations essentially similar to those characteristic of the solid state, the chief difference between the solid and the liquid states being that in the latter the amplitudes of the vibrations are so large that molecules make collisions (resulting in 'temporary unions') with neighbours at every extreme displacement. His viscosity equation is

$$\eta = \frac{4}{3} \cdot \frac{m\nu}{\sigma}, \qquad (1)$$

where η is the viscosity of the liquid, m the mass of a molecule in the liquid, ν its vibration frequency, and σ the average distance between the centres of the molecules.

From an essentially similar model, Osida[2] deduced that

$$K = \frac{4k\nu}{\sigma}, \qquad (2)$$

where K is the heat conductivity of the liquid and k the gas constant per molecule.

From (1) and (2),

$$mK/\eta = 3k.$$

Multiplying each side by the Avogadro number N,

$$NmK/\eta = 3Nk,$$

or as the molecular weight $M = Nm$ and the molar gas constant $R = Nk$,

$$MK/\eta = 3R. \qquad (3)$$

Since R in calories is very nearly 2,

$$MK/\eta = 6;$$

K is in calories, and η in poises.

In the accompanying table are shown values for the molecular weight in the vapour state M, the heat conductivity at the boiling point (a 'corresponding' temperature) K_{bp} in calories, the viscosity at the boiling point η_{bp} in poises and MK_{bp}/η_{bp} of some 'normal' liquids, K for which is known fairly accurately from Bridgman's measurements[3]. Values for K_{bp} have been calculated from Bridgman's data at 30° and 75° C., assuming a linear relationship between K and temperature[4]. Values for η_{bp} are after Macleod[5]. It will be seen from the last column of the table that

Liquid	M	K_{bp}	η_{bp}	MK_{bp}/η_{bp}
Acetone	58·1	0·000414	0·00232	10·4
n-Pentane	72·1	320	200	11·5
Ether	74·1	328	205	11·9
Carbon disulphide	76·1	375	308	9·26
Toluene	92·1	319	248	11·9
Ethyl bromide	109	284	329	9·41
Ethyl iodide	156	261	371	11

$$MK_{bp}/\eta_{bp} = \text{constant}. \qquad (4)$$

The mean value of the constant is 10·8. It is evident from this that, to be applicable at the boiling point, the numerical coefficient in equation (3) requires modification. This can be done, satisfactorily enough, only on examination of a number of liquids. Unfortunately, however, data on K are scarce. Further, different methods of measurement yield varying values. Until these difficulties are overcome, the numerical coefficient in equation (3) can be modified tentatively to 5·4.

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Feb. 1.

[1] Andrade, *Phil. Mag.*, **17**, 497 (1934).
[2] Osida, *Proc. Phys. Math. Soc. Japan*, **21**, 353 (1939).
[3] Bridgman, *Proc. Amer. Acad. Sci.*, **59**, 141 (1923–24).
[4] Mohanty, *Curr. Sci.*, **17**, 148 (1948).
[5] Macleod, *Trans. Farad. Soc.*, **21**, 160 (1925–26).

Elastic Constants of Galena

Recently, Ramachandran and Wooster[1] have obtained the elastic constants of galena, among other substances, from measurements on diffuse reflexion of X-rays, and reported disagreement with the values given earlier by one of us[2]. Ramachandran has also directed our attention to this in private communications. This substance, in the light of such values, also figures as an exception in a paper by Lonsdale[3] dealing with the vibration amplitudes of atoms in cubic crystals. Its elastic constants have therefore been re-determined, employing the wedge method and a very much better crystal than was available at the time of the earlier investigations. Frequencies in the range 2–12 Mc./sec., and (001) and (111) sections of different thicknesses ranging from 1·450 mm. to 1·929 mm., have been used. Constants now obtained along with the bulk modulus K in units of 10^{11} dynes cm.$^{-2}$ are $c_{11} = 12{\cdot}70$, $c_{12} = 2{\cdot}98$, $c_{44} = 2{\cdot}48$ and $K = 6{\cdot}22$. They show that the Cauchy relation is fairly well satisfied. c_{44} and c_{12} do not differ very much from those of Ramachandran and Wooster, whereas c_{11} is somewhat larger. These values are to be regarded as much more reliable than any published earlier.

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Feb. 26.

[1] Ramachandran, G. N., and Wooster, W. A., *Nature*, **164**, 839 (1949).
[2] Bhagavantam, S., 33rd Ind. Sci. Cong., Pres. address, Section of Physics (1946).
[3] Lonsdale, K., *Acta Cryst.*, **1**, 142 (1948).

FORTHCOMING EVENTS

Tuesday, July 10—Friday, July 13

MEDICAL RESEARCH COUNCIL OF IRELAND (at University College and Trinity College, Dublin).—Colloquium on "The Chemotherapy of Tuberculosis".

Thursday, July 12

UNIVERSITY OF LONDON (in the Physiology Theatre, St. Mary's Hospital Medical School, Paddington, London, W.2), at 5 p.m.—Prof. F. Verzar (Basle): "One or Several Adrenal Cortical Hormones".

Friday, July 13—Sunday, July 15

BRITISH MYCOLOGICAL SOCIETY (at Bristol).—Plant Pathology Field Day, Bristol Meeting, and Cotswold Foray.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMIST for work on the co-ordination of research and development on insecticides and fungicides—The Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1 (July 14).

DAIRY CATTLE HUSBANDRY OFFICER—The Director, Animal Breeding and Genetics Research Organization, Glenbourne, South Oswald Road, Edinburgh 9 (July 14).

LECTURER IN AGRICULTURAL SCIENCES at the Cheshire School of Agriculture, Reaseheath, Nantwich—The Director of Education, County Education Offices, City Road, Chester (July 14).

LECTURER IN MATHEMATICS—The Registrar, Technical College, Sunderland (July 14).

LECTURER IN METALLURGY at the Technical College of Monmouthshire—The Director of Education, County Hall, Newport, Mon. (July 14).

LECTURER IN PHYSICS, to teach Physics to B.Sc. (General) degree standard—The Principal, Enfield Technical College, Queensway, Enfield, Middx. (July 14).

RESEARCH DEMONSTRATOR IN BOTANY—The Secretary and Registrar, University College of North Wales, Bangor (July 14).

SCIENTIFIC OFFICERS (2, with good honours degree in botany or agricultural botany) for vacancies, one in grass breeding and one in grassland agronomy, at the Welsh Plant Breeding Station—The Registrar, University College of Wales, Aberystwyth (July 14).

SENIOR ASSISTANT ENGINEER—The Engineer to the Essex Rivers Catchment Board, Essex Rivers House, Springfield Road, Chelmsford, Essex (July 14).

CURATOR (University degree essential and the Museums Association diploma desirable) IN ARCHÆOLOGY AND ANTHROPOLOGY—The Director, City Museum, Bristol (July 15).

DEMONSTRATORS IN THE BIOLOGY DEPARTMENT—The Registrar, University College of North Staffordshire, Keele, Staffs, endorsed 'Biology Demonstrator' (July 15).

LECTURER IN MATHEMATICS, and a LECTURER IN ANATOMY, at University College, Dundee—The Secretary, The University, St. Andrews (July 15).

READER or SENIOR LECTURER IN CHEMICAL PATHOLOGY, and a DEMONSTRATOR IN PATHOLOGY—The Registrars, The University, Manchester 13 (July 15).

SENIOR LECTURER, and a LECTURER, IN ENGINEERING—The Registrars, The University, Manchester 13 (July 15).

SENIOR PROFESSIONAL OFFICER (with an honours degree in agriculture, or some equivalent qualification, and specialized in field crops and in soil physics and chemistry), at the Sabi Valley Experimental Station, Division of Agriculture and Lands, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (July 15).

DEPUTY CHIEF ENGINEER—The Chief Engineer, Southend Waterworks Company, 13 Cambridge Road, Southend-on-Sea (July 16).

DIRECTOR OF FISHERIES, East Bengal—The High Commissioner for Pakistan, 35 Lowndes Square, London, S.W.1 (July 16).

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT (industrial or analogous experience desirable, with special interests and experience in radio engineering with particular reference to microwave technique)—The Head of the Electrical Engineering Department, City and Guilds College, Exhibition Road, London, S.W.7 (July 16).

RESEARCH ASSISTANT FOR ELECTRON MICROSCOPY—The Registrar, The University, Leeds 2 (July 16).

VIROLOGIST (male) to undertake research on virus diseases of fruit and hops (with special reference initially to the latter crop)—The Secretary, East Malling Research Station, Maidstone, Kent (July 16).

READERSHIP IN MINING—The Assistant Registrar, King's College, 23 St. Thomas' Street, Newcastle-upon-Tyne (July 17).

ASSISTANT DIRECTOR (Technical Underground) IN THE CENTRAL RESEARCH ESTABLISHMENT, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/349 (July 18).

PRINCIPAL SCIENTIFIC OFFICERS and SENIOR SCIENTIFIC OFFICERS in the Ministry of Food: (*a*) in London, PRINCIPAL SCIENTIFIC OFFICER (with a degree in biochemistry with biological subsidiary subjects, and experience in quality control and manufacture of foods essential) to take charge of the section dealing with the technological aspects of food hygiene and welfare foods; (*b*) in Aberdeen, PRINCIPAL SCIENTIFIC OFFICER (with a degree in botany or biochemistry, research experience in plant physiology and plant biochemistry; industrial experience of processing of vegetable products essential) to take charge of the section dealing with vegetable dehydration; (*c*) in London, PRINCIPAL SCIENTIFIC OFFICER (with a degree in chemistry or biological sciences, and practical experience of research and development in food production) to maintain liaison between the Department's Scientific Adviser, other Government departments and branches of industry concerned with manufacture and use of foods for emergency purposes; (*d*) in London, SENIOR SCIENTIFIC OFFICER (with a degree or an equivalent qualification, including chemistry and biological sciences) to undertake investigations in quality and reduction of wastage in foods; (*e*) in London, SENIOR SCIENTIFIC OFFICER (with a degree in biochemistry, physiology or chemistry) for advisory and survey work in nutrition; a knowledge of modern theory and practice of nutrition is essential; (*f*) in Aberdeen, SENIOR SCIENTIFIC OFFICER (with a degree in biochemistry or botany; research experience in plant biochemistry desirable) to undertake research on biochemical problems—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.4037/51 (July 19).

SENIOR PRINCIPAL PRODUCTION ENGINEER, Admiralty Production Pool—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.4038/51 (July 19).

PROFESSIONALLY QUALIFIED CHEMIST as Assistant Secretary (Scientific)—The Secretary, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1, marked 'Private' (July 20).

ASSISTANT LECTURER IN BOTANY, for B.Sc. (Agric.) and B.Sc. (Hort.) degree courses—The Registrar, Wye College, Wye, Kent (July 21).

BOTANIST (with a good honours degree, and research or other experience in plant breeding, genetics or horticulture) for fruit-breeding—The Secretary, East Malling Research Station, Maidstone, Kent (July 21).

CHEMISTS (Senior Scientific Officer, Scientific Officer, Senior Experimental Officer, Experimental Officer, and Assistant Experimental Officer grades) at the Ministry of Supply Radiochemical Centre, Amersham, to be concerned with the synthesis of compounds labelled with radioactive isotopes, particularly Carbon-14, and with allied research problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.365/51A (July 21).

EDUCATIONAL PSYCHOLOGIST (woman, with honours or research degree in psychology) in the Somerset Child Guidance Service—The Chief Education Officer, County Education Office, Trull Road, Taunton (July 21).

LECTURER IN PHYSICS, and a LECTURER IN PHARMACOLOGY—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (July 21).

RESEARCH DEMONSTRATOR IN ZOOLOGY—The Registrar, The University, Sheffield (July 21).

RESEARCH OFFICER (Veterinary Physiologist) IN THE DIVISION OF ANIMAL HEALTH AND PRODUCTION, at McMaster Animal Health Laboratory, Sydney, N.S.W., to undertake research on animal physiology, especially on the physiology of the alimentary canal of ruminants—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3445 (July 21).

ASSISTANT LECTURER IN THE HYDRAULICS DIVISION of the Civil Engineering Department—The Head of the Department of Civil Engineering, Imperial College of Science and Technology, South Kensington, London, S.W.7 (July 23).

RESEARCH FELLOWSHIP IN THE DEPARTMENT OF MATHEMATICAL PHYSICS—The Deputy Secretary, The University, Birmingham 3 (July 25).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree, preferably in engineering, and some industrial and research experience) in the Mechanical Engineering Research Organization (Department of Scientific and Industrial Research)—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4041/51 (July 26).

LECTURER IN ENGINEERING—The Secretary, The University, Aberdeen (July 27).

ASSISTANT EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER IN THE HYDRAULICS RESEARCH ORGANIZATION (Department of Scientific and Industrial Research), Wallingford, Berks, to assist in hydrographic surveying of beaches and estuaries and also to assist in research into the effect of waves and currents on beaches—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting E.270/51 (July 28).

ASSISTANT LECTURERS IN ELECTRICAL ENGINEERING—The Registrars, The University, Manchester 13 (July 28).

CHEMISTS (with a four-year University degree in science with chemistry as a major subject; experience in analytical work is essential and a specialized knowledge of pedology or soil science desirable) in the Chemistry Branch of the Division of Agriculture and Lands, Southern Rhodesia Government—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (July 28).

RESEARCH OFFICER IN THE ORGANIC CHEMISTRY SECTION, Division of Industrial Chemistry, Fishermen's Bend, Melbourne, to aid with investigations in progress on the chemistry and the refining of cane and other waxes—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3460 (July 28).

ANALYTICAL CHEMIST (with a degree in chemistry, biochemistry, or agricultural chemistry, preferably with honours) to be responsible for analytical work on grass and grass products, and an ASSISTANT ADVISORY OFFICER IN MYCOLOGY (with an honours degree in botany with specialization in either mycology or plant physiology, or a degree in agriculture with postgraduate study in these subjects)—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (July 31).

ASSISTANT CURATOR OF THE PATHOLOGICAL MUSEUM (the Keith Museum) of the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 31).

CHAIR OF AGRICULTURE at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 31).

CHAIR OF PHILOSOPHY in the Faculty of Theology, Royal University of Malta—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

CHIEF AGRICULTURAL ECONOMIST (with a specialized degree in agricultural economics) in the Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (July 31).

DEMONSTRATOR IN GEOGRAPHY—The Secretary, The University, 38 North Bailey, Durham (July 31).

INSTITUTION OF GAS ENGINEERS RESEARCH FELLOWSHIP for post-graduate research in gas chemistry—The Registrar, The University, Leeds 2 (July 31).

LECTURER IN ECONOMICS at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

LECTURERS or ASSISTANT LECTURERS (3) IN GEOGRAPHY, to carry out research in climatology and oceanography, historical geography, plant and animal geography, social geography, and field work, with special reference to Malaya and South-East Asia, at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 31).

LECTURER IN CIVIL ENGINEERING, and a LECTURER IN MECHANICAL ENGINEERING, at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 1).

RITCHIE PROFESSOR OF RESEARCH IN ECONOMICS at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 7).

VETERINARY OFFICERS and RESEARCH OFFICERS in the Ministry of Agriculture and Fisheries—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 130–173/51 (August 9).

LECTURER IN MATHEMATICS at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 15).

SENIOR LECTURER IN FLUID MECHANICS AND HYDRAULICS, and a LECTURER IN CIVIL ENGINEERING, at Canterbury University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.2 (August 20).

LECTURER IN GEOGRAPHY—The Secretary, The University, 38 North Bailey, Durham (August 31).

ALLEN AND HANBURY'S RESEARCH FELLOWSHIP (applicants must be pharmaceutical chemists or graduates in pharmacy, science or medicine of a university)—The Secretary, School of Pharmacy (University of London), 17 Bloomsbury Square, London, W.C.1 (September 1).

RESEARCH FELLOWSHIP IN THE DEPARTMENT OF ELECTRICAL ENGINEERING, for research in the field of vacuum insulation—The Registrar, Queen Mary College, Mile End Road, London, E.1 (September 1).

LECTURER IN MATHEMATICS at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 15).

ASSISTANT EXPERIMENTAL OFFICERS (including biologists) in various Government departments and divided between the following main groups and subjects: (*a*) mathematical and physical sciences, (*b*) chemistry and metallurgy, (*c*) engineering subjects, and (*d*) miscellaneous (including geology, library and technical information services)—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3068 (October 1).

CIVIL ENGINEERS, SANITARY ENGINEERS and STRUCTURAL ENGINEERS in a number of Departments in England and Scotland—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3405.LA (December 31).

ASSISTANT ENGINEER in the Public Works Department, North Borneo—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/48.

ASSISTANT LECTURER IN THE SCHOOL OF PHYSICS AND ALLIED SCIENCES—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

BIOCHEMIST to carry out research and other routine work in the Institute of Medical Research, Federation of Malaya—The Director of Recruitment (Colonial Service), 2 Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27106/49/51.

CIVIL ENGINEER (Ref. No. 27322/211), and a MECHANICAL ENGINEER (Ref. No. 27333/39), to the Jamaica Government Railway—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting the appropriate Ref. No.

DEMONSTRATOR IN BOTANY at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

DEVELOPMENT GROUP MANAGER (with a good honours degree in chemistry, physical chemistry or physics, associateship of the Royal Institute of Chemistry or the Institute of Physics, or equivalent qualifications) at the Ministry of Supply Factory, Division of Atomic Energy (Production), Capenhurst, Chester, to take charge of an applied research and development laboratory engaged on special development work for a new atomic energy project—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

ELECTRICAL ENGINEERS in the Electrical Engineering Department of the Admiralty—The Admiralty (C.E.H., Room 88), Empire Hotel, Bath.

EXECUTIVE ENGINEER in the Department of Works and Hydraulics, Trinidad—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/16.

HORTICULTURAL PRODUCTION AND MARKETING OFFICER—The Controller, Land Settlement Association, 43 Cromwell Road, London, S.W.7, endorsed 'H.O.'.

INSPECTORS OF AGRICULTURE (4) in the Ministry of Agriculture, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Inspector of Agriculture—4/11'.

INSPECTORS OF MINES in Malaya—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27099/5A.

INSTRUMENT ENGINEER (with an honours degree in engineering corporate membership of one of the Institutions of Mechanical or Electrical Engineers, or equivalent qualifications) at Windscale Works, Sellafield, Cumberland, to be responsible for the supervision of work in shops engaged in the construction, installation, maintenance, repair and calibration of a wide variety of instruments—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting WD.3/1.

LECTURER IN MECHANICAL ENGINEERING—The Secretary and Registrar, University College, Southampton.

LECTURER IN METALLURGY—The Registrar, University College, Singleton Park, Swansea.

LECTURER IN PHYSICS—The Principal, North Staffordshire Technical College, Stoke-on-Trent.

PROFESSIONAL ENGINEERS, General Service Class (Main and Senior grades), in the Admiralty and other Government departments—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.86/51.

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS in various Government Departments and covering a wide range of scientific research and development in most of the major fields of fundamental and applied science—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3399.

SONICS SCIENTIST (physicist or biophysicist with Ph.D. degree, good grounding in acoustics with two or more years experience in sonic research, British) to be responsible for a sonics section with a staff of several junior scientists—The Director of Research Personnel, Defence Research Board, Department of National Defence, 'A' Building, Ottawa, Ont., Canada, quoting Competition G-8.

WORKS MANAGER (with either *a*, an honours degree in engineering or corp. rate membership of the Institution of Mechanical or Electrical Engineers, or *b*, an honours degree in chemistry or physics and associateship of the Royal Institute of Chemistry or the Institute of Physics) at the Ministry of Supply Factory, Division of Atomic Energy (Production), Capenhurst, Chester, to be responsible for the operation of a large chemical engineering plant engaged in the production of atomic energy material—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting 'CB/3'.

REPORTS and other PUBLICATIONS

(not included in the Monthly Books Supplement)

Great Britain and Ireland

British Library of Political and Economic Science. Annual Report, 1949–50. Pp. 20. (London: British Library of Political and Economic Science, London School of Economics and Political Science, 1950.) [244

University of London: University College. Annual Report, October 1949–September 1950. Pp. 171. (London: University College, 1951.) [244

International Council of Scientific Unions. Report of the Executive Committee, 1950. Edited by F. J. M. Stratton. Pp. viii+78. (Cambridge: At the University Press, 1951.) 5*s*. [244

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper No. 20: Pavement Design for Roads and Airfields. By E. H. Davis. Pp. vi+50. (London: H.M. Stationery Office, 1951.) 1*s*. 9*d*. net. [244

Library Association (London and Home Counties Branch). Report on the Municipal Library System of London and the Home Counties, 1949. General Editor: James D. Stewart. Pp. 32. (London: Library Association (London and Home Counties Branch), Central Public Library, Hampstead, 1950.) [254

Other Countries

International Union for the Protection of Nature. Proceedings and Reports of the Second Session of the General Assembly, held in Brussels, 18–23 October 1950. Pp. 32. (Brussels: International Union for the Protection of Nature, 1951.) [244

Koninklijk Nederlands Meteorologisch Instituut, De Bilt. No. 108: Seismic Records at De Bilt, 34, 1946. Pp. vii+33. 1 f. No. 125 (Mededelingen en Verhandelingen, Series B, Deel 11, No. 13): An Investigation on some Aspects of the Effect of Land and Sea Breezes. By Dr. F. Balkema. Pp. 50. 1.50 f. ('s-Gravenhage: Staatsdrukkerij- en Uitgeverijbedruf, 1950.) [244

Scientific Institutions and Scientists in Latin America. Venezuela, Vol. 1. Pp. iii+131. (Montevideo: Unesco Centro de Cooperación Científica para América Latina, 1951.) [244

Fieldiana. Zoology, Vol. 31, No. 41: A Review of the Woodpeckers *Chrysoptilus melanochloros* and *C. melanolaimus*. By Melvin A. Traylor, Jr. Pp. 421–438. 20 cents. Zoology, Vol. 31, No. 42: Amphibians and Reptiles of the Hopkins–Branner Expedition to Brazil. By Karl P. Schmidt and Robert F. Inger. Pp. 439–466. 40 cents. Zoology, Vol. 31, No. 43: A New Lizard of the Genus Varanus from New Guinea. By Robert Mertens. Pp. 467–472. 10 cents. Zoology, Vol. 31, No. 44: Two New Mammals from Southern Peru. By Colin Campbell Sanborn. Pp. 473–478. 10 cents. (Chicago: Chicago Natural History Museum, 1951.) [244

Catalogues

Gallenkamp Universal Water-Baths. (Publication 531.) Pp. 4. (London: A. Gallenkamp and Co., Ltd., 1951.)

Murex Review. Vol. 1, No. 8. Pp. 165–198. (Rainham: Murex, Ltd., 1951.)

BTL Bulletin and Laboratory Notes. Series 2, No. 17, April. Pp. 32. (Chadwell Heath: Baird and Tatlock (London), Ltd., 1951.)

The Nivoc Supplement. Spring 1951. Pp. 20. (London and Birmingham: W. and J. George and Becker, Ltd., 1951.)

Medical Books. Pp. 80. (Edinburgh: E. and S. Livingstone, Ltd., 1951.)